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RELATION OF JAMES HALL TO AMERICAN GEOLOGY.

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PROFESSOR JAMES HALL may not be so good a geological delineator as W. W. Mather, nor so keen or so original a thinker in dynamical geology as E. Emmons, a less learned man than Lardner Vanuxem, and in no respect so accomplished a zoologist as T. A. Conrad ; yet the fame of James Hall will, meritoriously, far outrank the collective reputation of his four collaborators.

Hall was gifted with the power of generalization, a distinct talent to give territorial expansion to groups of separated observations, and to step outside of the limits of a conventional geological creed. And he possessed the faculty of assimilation. He derived important suggestions from previous research, listened attentively to verbally conveyed views, and could appropriate skillfully the results of labors not his own, when they fitted into the scheme of his laborious research. As a purely mechanical advantage, Hall evinced a literary superiority. His style is flowing and expressive, of much lucidity in language, and — simply because he was not an erudite or exhaustive thinker — attractively clear and intelligible in composition.

In Hall there was a distinct philosophical aptitude, sometimes evinced in remarks outside of the range of strictly scientific study, and this philosophical instinct led him into paths of induction which freed him from the bonds of stereotyped views in science itself. This *disquisitional* quality, as I venture to call it, is not inconsiderably shown in the opening pages of his "Preliminary Considerations" to the *Report on the Geology of the Fourth District*, in the same way that the pedagogical strain of his mind appears in the two or three succeeding chapters of the same work.

As illustrating both of these traits, under a somewhat oracular disguise, the following paragraph is of interest. It closes some remarks made upon the absence of the coal formations in New York State, for whose fancied presence money and labor had been unavailingly expended in exploration :

"It is thus negatively, as well as by direct and positive discoveries, that science ameliorates the condition of mankind; turning attention from useless and visionary pursuits, and directing it to that which yields a ready and satisfactory result for the expenditure of labor and time. And although the promulgation of scientific truths may restrain the vagaries of minds which delight to build the splendid air castles of suddenly acquired wealth, it will, nevertheless, direct man's energies to sources where perseverance is sure to be crowned with rewards which a morbid fancy would crave at the commencement of the enterprise. From science alone will man learn his true interests as regards his well-being in the world."

It was the philosopher in Hall which led him along the lines of wide conclusions so favorably and notably shown in the introduction of vol. iii of the *Paleontology of New York*. Here, as Walcott once remarked to the writer, "the substantial worth of Hall as a geological writer is fully illustrated," for in these ninety-six pages he sketches with considerable mastery at least, the relations of the palæozoics in the east, points out the misleading assumption of a Taconic system, and projects the theory of troughs of sedimentation as essential causes of mountain-making, a theory he had before laid before the scientific world in the *Proceedings of the American*

Association for the Advancement of Science. It was the philosopher in Hall which as early as 1839 or 1840 led him to instinctively enlarge and multiply the observations of Vanuxem, published in 1829, upon the identity of western formations with those of New York. It was the philosopher in Hall which saved him from Eaton's mistake in applying Wernerian categories to the New York rocks, and caused him to sweep the cobwebs of imitation and preconception from his eyes as he read the story of geological succession in their strata. He corrected the "distortion" (as he expressively termed it) which had made the even bedded layers of western New York equivalents of the so-called "secondary" rocks abroad, and discarded the illusion of an exact resemblance in the geology of Europe and America.

But this philosophic endowment did not endanger his physical activity. Less poetic and distinguished in mind or temperament than the Professors Rogers, his tireless curiosity and enthusiasm brought him in contact with a wider range of geographical and geological facts. He traveled extensively and made the results of his experience and his collections bear upon the elucidation of the geology of New York State.

It was fortunate that a philosophical mind, one addicted to comparison and induction, and not gifted either with marked scholarship or originality, should have been committed to the task of studying a section (the Fourth District) of the state where the succession was almost undisturbed, where leaf upon leaf, with contents unobliterated, the geological record, waited for its reader. Hall read the record and established the *pagination* of the opening sections of the Book of Geology for America. Imbued with lasting impressions of a quiet and continuous progress of deposition, marked by no more extreme perturbations than the secular rising and falling of the earth's crust, he became a strict Uniformitarian, and the problems of volcanic geology, which lay far outside of his path, seldom or never enlisted his attention. He writes in the *Geology of the Fourth District* (p. 10) : "The doctrine of violent catastrophes, and of sudden changes in the inhabitants of the ocean, was based upon the examination of limited districts, where the

entire series of deposits had never existed, or had been subsequently obliterated. And gradual and tranquil as the changes now seem to us, they may appear infinitely more so when a perfect sequence among the strata of the whole globe shall become known — when a *complete* succession shall be established from the oldest to the newest rock. From what we now know, compared with the knowledge existing a few years since, we can readily infer that some distant places, or even nearer localities, may furnish links now wanting in the chain." Hall's phenomenal vitality carried him through a period of geological research in which some of his expectations were verified.

The Fourth District, extending from Chautauqua and Niagara on the west to Wayne and Chemung on the east, was practically fully deciphered by Hall in its intrinsic stratigraphy, though the exact and complete outline of its formations has only recently been mapped. This region, so uniformly constructed, and referring so perspicuously to its origin in just such conditions as prevail along the margins of existing continents, appealed strongly to Hall's logical temperament. He writes of it :

"The analogy to recent formations is thus more fully seen; for we have precisely the same materials, differing only in degree of induration. We have the unaltered monuments of a widespread ocean teeming with life, and we find recorded its changes through vast periods of time. We now learn what were the conditions of its bed at these successive periods, and also what different characters it presented at distant points. The varying forms of its inhabitants are as well marked and as perfectly preserved as the recent species amid the mud and sand and pebbly bottoms of our present seas. The geographical limits of certain genera and species are as well defined in that primeval ocean as in the present; and, as now, upon the same bottom, we find in some places great accumulations of organic forms, while in others they are rare or wanting. Like our present ocean also, we know that this ancient one was agitated by winds and moved by tides; the drifted shells and comminuted corals tell us plainly of waves and currents, while in other places the fine sediment and equally distributed organic

remains speak either of a quiet sea or deep water, where they were placed beyond the tumult that might have raged nearer the surface."

Hall's study of this succession, and the generally increasing thickness of deposits to the east along the Appalachian uplift, his generalizations upon the continuity of these beds westward, and his growing realization of successions of fauna, with more or less clear appreciation of local variations in fauna, were resumed in the interesting and able introduction to vol. iii of the *New York Paleontology* (1859). The fact of the preponderant accumulations of sediment along the Appalachians had been reviewed and studied by him with an increasing certainty of divination that the association of these heavy deposits with the mountain chain itself was in the nature of a causal connection.

Hall had apprehended with his usual power of appreciative insight the dissertation of Herschel on the mobility of the earth's crust, and it was an exhibition of hermeneutics in geological science which read into the facts of the Appalachian tumulus the specific applicability of the suggestion. Here he saw a continental ridge made up of sedimentary rocks, twisted and folded, to be sure, and showing the results of powerful compression. But the mass, the vast aggregate of its limestones, slates, and sandstones, was sedimentary, and these deposits were evidently concentrated along a meridional crease, a trough or depression secularly raised and lowered. This path of sedimentation against and over an oscillating shore line provided the material, when raised, for a mountain chain. The trough was itself an inverted mountain ridge, and nowhere else was there such an adequate supply of *mass* to create an imposing elevation when lifted. As Hall succinctly said: "At no point, nor along any line between the Appalachian and Rocky mountains, could the same forces have produced a mountain chain, because the materials of accumulation were insufficient; and though we may trace what appears to be the gradually subsiding influence of these forces, it is simply in these instances due to the paucity of the material upon which to exhibit its effects. The parallel lines of elevation, on the west of the

Appalachians, are evidenced in gentle undulations, with the exception of the Cincinnati axis, which is more important, extending from Lake Ontario to Alabama, and is the last or most western of those parallel to the Appalachian chain."

It does not appear clearly that the physical consequences of his views were ever elaborated in his own mind, or that the thermal features of the problem, as somewhat narrowly presented by T. Mellard Reade, were studied. Indeed, there is discernible in Hall's writing a shrinking from the reference of mountain topography to dynamical agencies, but a quick response of interest to their indications of sculpture by erosion. If we might venture a pleasantry, we should say that if Professor Hall, as *deus ex machina,* had been permitted to have his own way, the Catskill rather than the Appalachian type of mountains would have been most widely distributed over the earth's surface.

Certain metamorphism and folding were recorded, and the contrasted phases of mountain-making exhibited in the Catskills and the Appalachians pointed out, but the metamorphism and folding were referred to the consequences of *weight* and not to crustal shortening. Here again Hall was quick to respond to contemporaneous investigation. He recognized that the facts of metamorphism did not require an enormous heat, and hinted at those hydrothermal processes which lithologists now find so active and efficient in producing mineral alteration. He says: "We must therefore look to some other agency than heat for the production of the phenomena witnessed; and it seems that the prime cause must have existed within the material itself, and that the entire change is due to motion, or fermentation and pressure, aided by a moderate increase of temperature, producing chemical change."

The view of mountain-making propounded by Hall was an illustration of common sense illumined by thought and observation. Yet it was in the nature of a revelation. Le Conte has told us "the idea was so entirely new, so utterly opposed to prevailing views, that it was wholly incomprehensible even to the foremost geologists. There was no place in the geological mind where it could find lodgment. It was curious to observe

the look of perplexity and bewilderment on the faces of the audience. Guyot was sitting immediately behind me. He leaned forward and whispered in my ear, 'Do you understand anything he is saying?' I whispered back, 'Not a word.'" This was scarcely a reflection on the intonation of the reader, but a truthful picture of mental consternation. Yet physico-chemical and mathematical obscurities could hardly be expected from Hall. The promulgation of his theory of mountain-making evinced and was the result of the instinct and experience of a stratigrapher.

It is impossible to read the dignified reports of the first, second, third, and fourth districts, strong and copious contributions to geology at a period in our scientific life when, except for differential or sporadic work at the hands of Eaton, McClure, and Featherstonhaugh, and more consecutive efforts from Jackson, Hitchcock, Troost, Percival, and Owen, nothing had been done in geology of commanding excellence — except the great work of the Professors Rogers — it is impossible to read these productions without being struck with the literary smoothness and the mental solidity of the *Report on the Fourth District*.

Here the pervading skill of presentation admirably expresses the geological simplicity of the facts. But the care and beauty of demonstration are happily united with suggestion. At one point we are invited to consider the varying rates of deposition for fine or heavy sediments, at another the character of shore and off-shore deposits, here the mechanics of river erosion are discussed, and there the alternating velocity and slowness of tides. We ponder on the changing colors of strata and what they mean, or are made to feel by some analogy how real those ancient beaches and ocean beds were. We are carried across Lake Ontario, and shown the Laurentian base of our system upon which in shelving order the later formations lie, appearing on the southern borders of the lake as the Upper Silurian ; and the realization of this is made distinct and memorable.

Hall's relation to American geology is that of the *illuminator*. He presented a broad, intelligible proposition, and on its basis a mass of evidence fell into discrete symmetry. Such was the succession of overlapping strata, their encircling lines

of deposition around an interior basin, the Taconic system as a changed Silurian system, mountains as rock heaps, faunal categories, and cycles.

This illuminating power was indeed due to a certain plainness in Hall's mind that led him to reject arduous and difficult theories. And it led him on the straight sunlit path when a more abstruse mind would have been, with great effort, working away from the truth underneath the ground. The work of correlation of the fossil horizons of the United States, done by Hall, was largely based upon fossil evidence as well as topographic continuity, and this correlation personally established by himself, as it was more and more supported by fresh evidence and new workers, laid bare the simplicity of the geology of the east and middle United States.

Indomitable in desire as he was in spirit, Hall reached the Rocky Mountains and established some of the first identifications of the Cretaceous in the west, and had begun there to show its varying character.

It belongs to the sensibleness of the man, the quality that often in other walks of life is the boon and the compensation of mediocrity, that Hall exercised a conservative influence in the terminology of the New York system. The names used by the New York geologists for the palæozoic formations remain, and are now printed as indelibly in memory as they are in books. They carry with them no euphonic distinction. They are not made educationally suggestive. They are eminently commonplace, and their *raison d'être* is absolutely obvious. Potsdam, Chazy, Calciferous, Black River, Trenton, Utica, Hudson River, Clinton, Medina, Niagara, and the rest are all place names easily understood, easily remembered, and have been easily applied to beds at localities most remote from all of them. Plain men like them, and scholars, have not replaced them by anything more refined. In this respect geology has both set and followed this example.

It belonged to the logic of Hall's mind and a certain original fixity of idea in him to combat Emmons' Taconic System. He rejected the injection of a new series of horizons. It complicated matters, and Hall shrank from enigmas. He looked upon

the schists, slates, and marbles of the green hills of Vermont as altered silurian sediments, and it has been the great distinction of the present Director of the United States Survey to prove this.

The same investigator has also vindicated the term "Hudson River" as embracing the section from the Trenton to the overlying Upper Silurian rocks, enclosing the Utica, a term instituted by the New York geologists, and more narrowly defined by Hall, though at first somewhat resisted by him.

Certainly to the far wider audience of scientific readers Hall stands as the embodiment of paleontological prestige. The enormous publications of the New York Survey, their later resplendent illustration, and the numerous dissertations and contributory essays on genera, families, morphology, and distribution of fossils, found in the *Reports of the New York State Cabinet*, have fixed the eye of attention upon Hall as a zoologist.

In no real sense was Hall a zoologist. His actual acquaintance with animal life was slight, and his system and habit of arrangement entirely mimetic. Certainly an enthusiastic and contemplative mind could hardly have escaped distinction in bringing to light the rising series of fossil forms which the regular succession of rocks displayed. Hall handled the retinue of forms thus presented with signal success. His work at first was tentative, but became increasingly valuable, especially as the influence of two great works educated his perception, and the influence of more acute zoologists, employed as his assistants, directed his discernment.

The formative influences of the Canadian Survey and Barrande's *Système Silurien* are plainly discernible in the progressive improvement of the *Paleontology of New York*. The Canadian Survey, with which for a short time he was connected, brought him into contact with a new field of fossil exploration, and he felt the stimulation of Sir William Logan as a helpful factor in his studies. The preparation of the decades and his close analysis of the graptolitic fauna were distinct advances over his former work in paleontology, wherein also it can hardly be denied that the extraordinary morphological instinct of Whitfield played a beneficial part. And in

Canada, besides the graptolites, the development of Crinoids and Cystids revealed a strange aspect of fossil life, repeated in the Niagara limestone of New York.

In Barrande's *Système Silurien,* a great work, exhaustively executed, Hall found strongly accentuated the fact of faunas and colonies, and the impression made by that work indorsed his own views and deepened them. Hall was not a thorough-going evolutionist, and Barrande's feelings about fixed types effected a permanent lodgment in Hall's zoological creed.

Hall's sanity, his reasonableness and restraint, is shown in his paleontological work, and reflects the sort of clarity of mind which distinguished his geological research. His literary instinct appears in his names also, which are pronounceable, well composed, and significant. His diagnosis of species and genera seemed remarkably correct. It was much later than his first work that he yielded to the solicitations of the hour and poured out species and genera so devotedly ; sometimes it is to be feared with a desire to obscure previous publications. Hall's diagnosis of Eurypterus, for instance, was admirable, though indisputably much of its perspicacity was injected from the careful comparative studies of Whitfield with Limulus. Agassiz, as is well known, coincided with these views.

The idiosyncrasies of Conrad, his unstudiousness, his carelessness and laconic methods, despite his genius in recognizing form, placed Hall's work at a surpassing distance beyond him. The appearance of the first two volumes of the *Paleontology of New York,* which were distinctively and, so to speak, indigenously Hall's work, marked a real epoch in scientific publication in this country. The wave of excitement spread abroad, and the keenest expectation was excited by the possibilities of a field of research, almost untouched, from which light might be expected upon the problems of life, new and brighter than that afforded in the similar areas of Europe.

When de Verneuil assured Hall of the striking specific contrasts, as well as the specific identities with those of Europe, amongst the fossils he was displaying to the scientific world, the path seemed opened for indefinite additions to the sum of knowledge in paleontology.

The consecutive arrangement of fossils from the various formations, their concentration in single volumes, the scale of illustration, all combined to give the publication a sort of encyclopedic character which, coupled with the promise of its continuous extension, made it a reference library of paleontology at that early day. It was continued, and as the finished and unexcelled drawings of Simpson and Whitfield, with the perfect lithography of Ast, gave it greater and greater luster, it grew upwards into the proudest monument perhaps ever erected to an American geologist.

It is interesting to read these early volumes, the starting points of American paleontology, and note the comparisons and observations. The author, with his characteristic love of illuminating observation, notes the varying character of the same species in successive beds or differing localities, compares and elucidates species, dwells on identity or contrast with European species, points out eccentricities of structure or ornament. These early volumes have a temporary, almost a temporizing character, are provisional in statement and necessarily imperfect in execution. The prolixity, evolution, and circumlocution of Barrande's work, published almost at the same time, contrasts almost amusingly with Hall's adequate but by comparison meager treatment, and of course Barrande's figures are incomparable, if a trifle mechanical and stiff. But Hall explains his own great difficulties — his small library, his distance from scientific friends, without authentic collections for comparison, in a new field, and with poor facilities for illustration. These impediments passed away. It is a part of that history of the development of paleontological science to note that at Albany was created a center of attraction and radiation, and two men became enlisted in this work whose special powers entered as determinative forces in its improvement — Whitfield and Meek. Later a higher stage even of erudition was reached, and Clarke and Beecher completed the assumption of the advanced biological expression.

What a development of scientific work in his own chosen field Professor James Hall has seen ! State surveys and the marvelous rise of the government surveys started up around

him, while the new energies of exploration and the deepened currents of study and insight ushered in our modern period with its exuberant hair-splitting and interminable terminologies.

Professor Hall is dead. Contest and contestant sleep in one grave. There lives above it the imperishable memory of an enthusiasm and a devotion which began the most glorious chapter of scientific progress in America.

THE WINGS OF INSECTS.

J. H. COMSTOCK AND J. G. NEEDHAM.

CHAPTER IV (*continued*).

The Specialization of Wings by Addition.

III. THE VENATION OF THE WINGS OF ODONATA.

THE wings of dragon flies have furnished the best of systematic characters since the days of Linnæus. The many peculiarities of venation have been slowly worked out and expressed in a formidable system of terms, most of which designate parts bearing other names in other orders. Indeed, this is not strange;

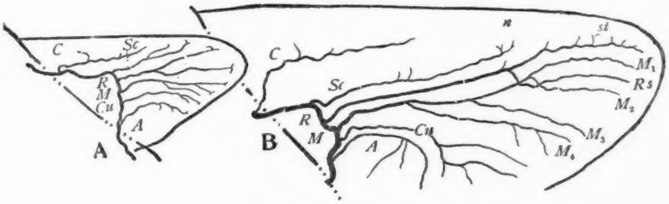

FIG. 60. — Wings of nymphs of *Gomphus descriptus*, early stages.

for, from the study of the adult wings alone, the discovery of the real homologies would be well-nigh impossible.

The richly veined wing of a dragon fly, at first sight, shows little in common with our hypothetical type. And even when the tracheation of the wing of an old nymph is studied, there are found some striking discrepancies. But in the budding wing of a young nymph we find an arrangement of the tracheæ which is almost that of the typical wing.

Fig. 60 represents the tracheation of two nymphs of *Gomphus descriptus*. The wing figured at *A* was only 1 mm. in length. Here is a costa with some anterior twigs, a subcosta with a terminal fork, a radius with its sector unbranched, a three-branched media, a cubitus which is two-branched in the usual

way, and a single anal vein with three branches, which may represent the three anal veins, fused at the base.

At *B* (Fig. 60) is represented the tracheation of a somewhat older wing, one measuring 3 mm. in length. Here the radial sector has shifted its position and lies across the end of the media, the terminal portion of it lying between M_1 and M_2. The media is now four-branched. The costal and anal tracheæ

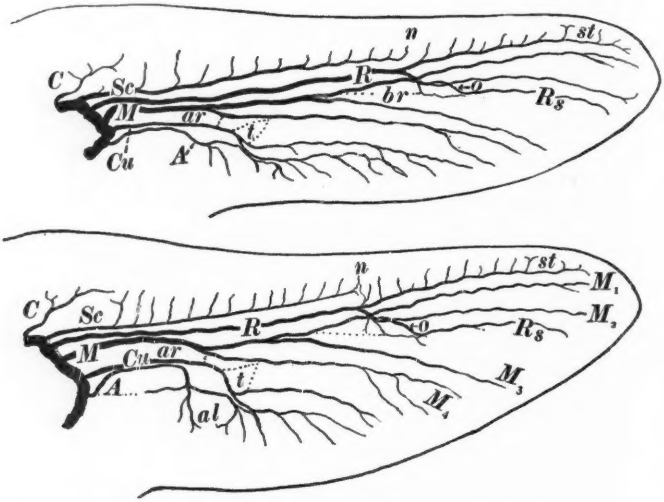

FIG. 61. — Fore and hind wings of a nearly grown nymph of *Cordulegaster diastatops*, showing tracheæ. *n*, nodus; *st*, stigma; *o*, oblique vein; *br*, bridge; *ar*, arculus; *t*, triangle; *al*, anal loop. The permanent venation which shows distinctly at this stage is omitted, except where indicated by dotted lines at the bridge, arculus, and triangle.

are outrun by the others in the occupation of the new territory formed by the growth of the wing, and remain relatively short.

In the wings of a grown nymph (Fig. 61) is seen the culmination of these tendencies. The radial sector has completed its migration and lies in its final position, the terminal portion traversing the area between M_2 and M_3. The costa is greatly reduced or, rather, outstripped by its competitors ; the same is true in a less degree of the subcosta and the anal vein. At this stage the veins, which are not represented in the figure, appear as pale, brownish thickenings ; surrounding all of the

principal tracheæ, and also surrounding the anastomosing tracheoles, which tend to group themselves in the positions of the cross-veins.

The most anomalous thing seen here is the position of the radial sector, a character which is quite distinctive of this order. In the adult wing (Fig. 62) this sector appears to be a branch of the media, and it has always been so interpreted. The only indication of its connection with the radius is the persistent obliquity of an apparent cross-vein between veins M_2 and R_s, just beyond the nodus.

The crossing of these tracheæ (Fig. 61) was first figured

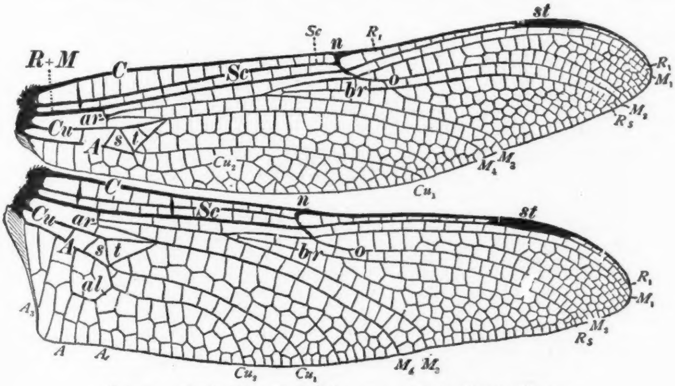

FIG. 62. — Adult wings of *Cordulegaster sayi*, lettered as in Fig. 61.

(incidentally) by Roster;[1] later it was described and discussed by Brauer and Redtenbacher;[2] and it was again figured and described by Brogniart.[3] But the effect of this crossing upon the homologies of the veins seems to have been overlooked. The apparent cross-vein is, in fact, a part of the radial sector; the longitudinal trunk connecting the sector with the media is not homologous with any of the principal veins, but is a secondary structure, developed for mechanical advantage, and the radial sector itself should be so termed, notwithstanding it appears to be a branch of the media and is far removed from

[1] Roster, D. A. *Bull. Soc. Ent. Ital.*, vol. xvii (1885), Pl. IV.

[2] Brauer u. Redtenbacher. *Zool. Anz.*, Bd. xi (1888), pp. 443–447.

[3] Brogniart. *Recherches sur les Insectes Fossiles* (1894), pp. 204–208, Pl. VIII.

its usual position. It will be convenient to designate that part of the radial sector which appears as a cross-vein behind vein M_2 as the *oblique vein* (Fig. 62, *o*); and the secondary longitudinal trunk as the *bridge* (Fig. 62, *br*).

In the adult wing the bridge exhibits no evidence of an origin different from that of the radial sector, with which it is strictly continuous. But a study of the tracheation of the

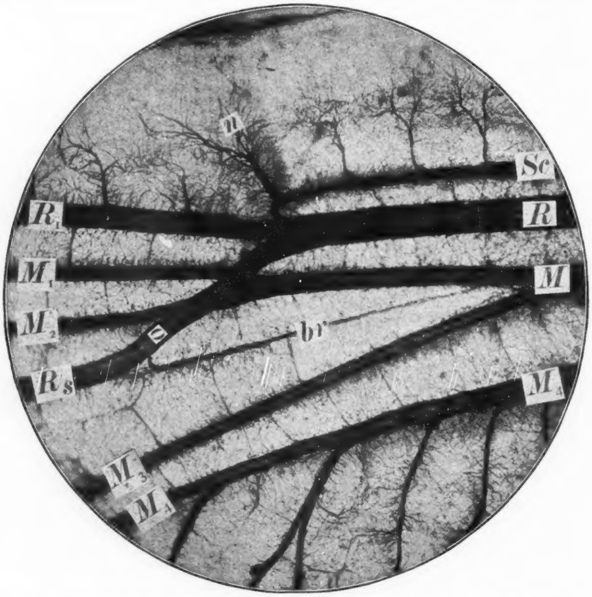

FIG. 63.—The region of the nodus in *Anax junius*, showing the crossing of the radial sector and the origin of the trachea which precedes the bridge. *o*, oblique vein; *br*, the bridge.

wings of nymphs reveals the secondary nature of the origin of the bridge. Fig. 63 is a reproduction of a photograph of a portion of a wing of a nymph of *Anax junius*, showing the crossing of the radial sector, and the origin of the trachea which precedes the bridge. The latter is a small twig which arises from the distal end of that portion of the radial sector which becomes the oblique vein, and extends towards the base of the wing in a direct line to the media. This method of formation of the bridge is characteristic of the Æschnidæ.

In most Libellulidæ a trachea, or a bunch of tracheoles, descends from near the base of the radial sector and forks at the level of the bridge, one branch going to the distal end of the oblique vein, the other going in a diametrically opposite direction to the media (Fig. 64).

The illustrations just given exhibit the structure of these parts in nymphs of the suborder Anisoptera. In the suborder Zygoptera (Calopterygidæ and Agrionidæ) there exists a strik-

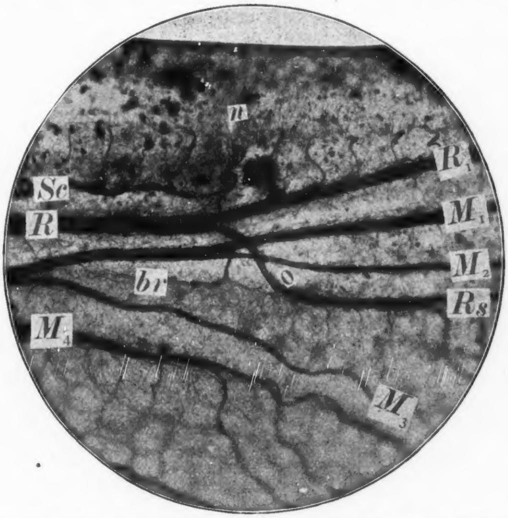

FIG. 64.—The region of the nodus in *Libellula pulchella*. *o*, oblique vein; *br*, the bridge.

ing difference. If we compare adult wings of the two suborders, there can be no question as to the identity of vein R_s, or as to its homology in the two groups. But in the suborder Zygoptera, so far as known to us, the trachea R_s is a branch of the medial trachea. The base of R_s, however, forms an oblique vein, and a bridge is developed secondarily, as in the Anisoptera. It is probable that there has been a switching of the base of the trachea R_s from trachea R to trachea M. One has only to examine a well-mounted wing of any dragon-fly nymph to see in the universal anastomoses of tracheoles communications already set up between principal tracheæ, any one of which

might be enlarged, should necessity arise for the entrance of air from a new quarter. Following this, the atrophy of the old connection would complete the switching; which, we believe, is what has happened in the Zygoptera. It follows from this that, so far as this portion of the wing is concerned, the Zygoptera depart more widely from the primitive type than do the Anisoptera. From this brief sketch it is evident that these parts will furnish systematic characters which are as yet unused.

For increasing its efficiency, certain methods of bracing the dragon-fly wing in its costal and basal parts have been perfected to a degree surpassing anything to be seen in any other order. The veins of the costal margin are thickened and approximated as usual; but the strong corrugation of the area traversed by them is maintained by their being bound together at the nodus, at the stigma, and often toward the base, where certain of the antenodal cross-veins become greatly thickened. These hypertrophied antenodals sometimes (as in Æschna) become stout triangular trusses which completely fill, in section, the furrow between the costa and the radius. Toward its base, the wing is braced by two characteristic structures well known in the literature of the Odonata as the *arculus* and the *triangle*. The arculus has already been discussed.[1]

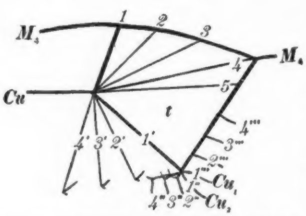

FIG. 65.— Diagram setting forth the behavior of the triangle in the suborder Anisoptera. The heavy lines bound a somewhat primitive triangle. 2, 3, 4, and 5 are stages in the descent of the upper cross-vein which are to be seen in such living genera as Tetrathemis, Anatya, Libellula, and Tetragoneuria, respectively. 1', 2', 3', and 4' represent successive stages in the retraction of the cubitus at the triangle, stages seen in the fore wings of Microdiplax, Anatya, Sympetrum, and Perithemis, respectively. 1'', 2'', 3'', and 4'' represent stages in the retraction of the base of vein Cu_2 as seen in the fore wings of Orchithemis, Anatya, Libellula, and Tetragoneuria. 1''', 2''', 3''', and 4''' represent stages in the ascent of the vein Cu_1 up the outer side of the triangle, stages seen in the hind wings of Ladona, Mesothemis, Anatya, and Nannodythemis.

The Triangle. — The deflection of the cubital trachea, just before its fork, makes a place for the development of the triangle. This is one of the most important features of the wings in the suborder Anisoptera, to which alone the following remarks will apply. While its stout bound-

[1] *American Naturalist*, vol. xxxii, No. 376, p. 234, Fig. 7.

aries unite strongly the three posterior longitudinal veins, only its inner side is bounded by a principal vein, its anterior and outer sides being formed from two cross-veins approximated upon vein M_4. Primitively it differed little from an ordinary rectangular cell. The accompanying diagram (Fig. 65) shows the successive positions assumed by its anterior and inner sides

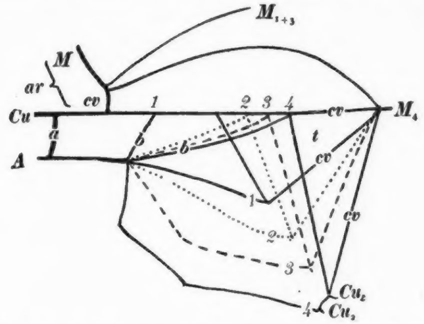

FIG. 66. — Diagram illustrating the procession of the triangle, and the deflection of the second Cu-A cross-vein in the fore wings of Libellulidæ. *a*, the first, and *b*, the second Cu-A cross-veins; 1, 2, 3, and 4, successive positions.

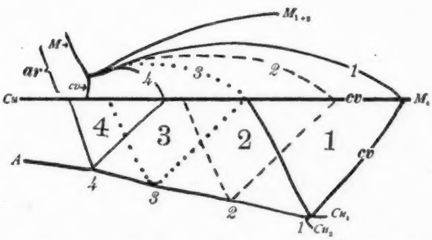

FIG. 67. — Diagram representing the recession of the triangle in the hind wings of the Libellulidæ. 1, 2, 3, and 4, successive stages.

and by the two branches of the cubitus at their departure from it. This epitome of its history presents only steps in its development that are still preserved in the wings of living genera.

In the Libellulidæ differentiation between fore and hind wing has changed the relation between arculus, triangle, and anal vein. Doubtless these were once similarly placed in the two wings, the triangle being a little beyond the arculus, and the anal vein meeting its hind angle in both wings (as, for

instance, at present in Cordulegaster). In the fore wing the anal vein has come to connect with the antero-internal angle of the triangle through the deflection of the second cubito-anal cross-vein, and the triangle has proceeded farther from the arculus. Successive steps are shown in the accompanying diagram (Fig. 66). In the hind wing the triangle has receded to the level of the arculus, or even a little farther, by the easy stages shown in the accompanying diagram (Fig. 67), and the second cubito-anal cross-vein has atrophied.

The Anal Loop. — There is also in the Anisoptera a strong tendency toward the development in the hind wing of a broadly expanded anal area — an aëroplane. This region remains still

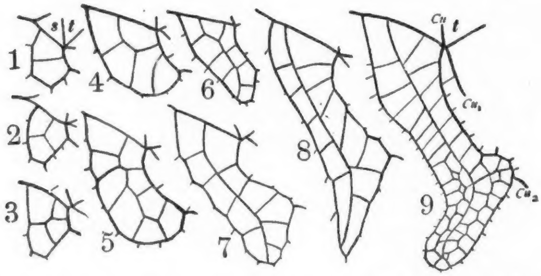

FIG. 68. — Forms of the anal loop in the Anisoptera: 1, anal loop of *Cyclophylla diphylla*; 2, of *Gomphoides stigmatus*; 3, of *Gomphæschna furcillata*; 4, of *Gomphomacromia paradoxa*; 5, of *Syncordulia gracilis*; 6, of *Agrionoptera insignis*; 7, of (?) *Nannophya maculosa*; 8, of *Ephidatia longipes*; 9, of *Hydrobasileus extraneus*.

unexplored territory. It will furnish, however, at least one character of much systematic importance. This is a space included between the first and second principal branches of the anal vein, which we designate as the *anal loop*. Its developopment is shown in Fig. 61. When developed in the Æschnidæ as a distinct enclosure, it is always compact in form, but in the more specialized of the Libellulidæ it becomes elongate, then gland-shaped, and then foot-shaped. Fig. 68 shows its more characteristic forms, and gives an idea of its variability within the group.

We have now indicated the homologies of the principal veins: we have briefly discussed the development of a few of the distinctive venational characters of this interesting group;

there is not space for details, but these are the less necessary because the junior author will shortly publish elsewhere an extended paper upon the venation of this order. It may be remarked, however, in passing, that the tendency throughout the order is toward vein multiplication. Additions are made upon both sides of several principal branches, and they conform to no one simple type. These new branches are preceded by tracheæ; but there are other interpolated veins developed for mechanical advantage quite independently of the tracheæ and cutting across them.

The radial sector is unique in form as well as in position.

All the peculiarities of this intricate venation have arisen out of the necessity for making all the veins individually useful: and those dragon flies which have been most successful in differentiating between the added veins are among the fleetest of winged creatures.

VARIATION IN THE SHELL OF HELIX NEMORALIS IN THE LEXINGTON, VA., COLONY.[1]

JAS. LEWIS HOWE.

THE colony of *Helix nemoralis* at Lexington, Va., has attracted considerable attention on account of the large number of varieties found. It was first studied by Major J. H. Morrison, then connected with the Virginia Military Institute. A very considerable number of specimens was collected by him and described by T. D. A. Cockerell.[2] Major Morrison sent out quite a number of colonies of the snails, that their variations in other localities might be studied, but only one of these colonies has been heard from. Early in his studies Major Morrison removed from Lexington, and soon after his records and much of his collection were destroyed by fire; hence he has been prevented from pursuing the study of the colony. Up to this time one hundred varieties had been described.

Later Mrs. John M. Brooke became interested in the subject, and from her collections a number of new varieties were described by Professor Cockerell.[3]

Last summer (1897), becoming interested through Professor Cockerell, I collected a series ("*A*") of 1134 shells from my garden and that adjacent. The two premises, with a narrow alley between, covered an area rather over 200 feet square. The present summer (1898) I collected on the same ground a second series ("*B*") of 1000 shells, and also a series ("*C*") from the garden where the colony originated. This series numbered 1258 specimens.

The colony is doubtless correctly believed to have had its origin in 1883, with the return of Mrs. John Moore from a European trip. Mrs. Moore ascribes the colony to straw used in packing goods from Florence. It is not impossible that it may have come from earth around a collection of ivies. The

[1] Read at the Boston Meeting of the American Association for the Advancement of Science, August, 1898. [2] *Nautilus*, November, 1889; December, 1894.
[3] *Science*, N.S. 5 (1897), 985.

ivy was from Kenilworth, Abbotsford, and Dryburgh, and was packed in earth at Queenstown. The garden where the snails were first noticed is about 200 yards from my garden. They spread at first with considerable rapidity, but since the first few years their limits have widened only slowly. As far as I can learn, by examination and inquiry, they are confined to a territory not over one and one-fourth miles long and one-half mile wide.

My aim in collecting the three series, which I hope at some future time to supplement, was to get light on the following questions: (*a*) Does the tendency to variation proceed along certain definite lines, and if so, what? (*b*) Does this tendency vary in different localities in the colony? (*c*) Will a very considerable destruction of individuals modify materially this tendency? A study of these three series seems to give an affirmative answer to "*a*" and "*b*," and a negative answer to "*c*."

The succeeding tables, which summarize the results of these series, have reference solely to the *banding* of the shell; of series *A*, 87%, and of series *B*, 83% are var. *libellula* (with yellow ground). In series "*C*" every shell but one is *libellula*.

The formulæ used in designating the varieties are those which have of late been generally adopted, and for a knowledge of which I am indebted to Professor Cockerell. The typical shell of the Lexington colony, or at least the most common variety (*libellula*), has a yellow ground and five bands,

Shell of *Helix nemoralis*. The bands are numbered 1 to 5. The right-hand figure shows bands 4 and 5 only.

three above the periphery and two (usually broader bands) below. These are numbered from the top of the body whorl (near the mouth) downward 1 2 3 4 5, as shown in the accompanying cut. A band which is incomplete or appears only in traces, *i.e.*, rudimentary, is designated in the formulæ by a small number, as $1_{2}345$. A band which is wanting is designated 0, as in 10345. Obviously there will be every intergrade between the formulæ, as between 12345 and $1_{2}345$. In some European shells a band is interrupted at intervals, and for this a colon (:) is used, but these have not been noticed in Lexington. When two bands

are fused into one, they are enclosed in a parenthesis, as 123(45). In my lists a distinction is made in the order of fusion, thus [(12)(3(45))] indicates that bands 4 and 5 are first fused, then band 3 unites with this fused band (45), bands 1 and 2 are also fused, and finally all the bands are united into one. An x is used to denote a band which cannot be referred to any of the usual five bands; such bands are generally rudimentary, but in a few instances they are equally strong with the other bands, and then designated by X. A split band is marked by doubling the number if both bands are strong, as 122345, and by adding a small number if one of the bands is weak, as 12_2345. In one case only a rudimentary band passes from one band to another, fusing first with one and then with the other; this is var. *libellula* $1(2(x)3)(45)$.

Table I. — Frequency of All Varieties Occurring More than Five Times.

(In percentage.)

Formula.	Series A.	Series B.	Series C.	Formula.	Series A.	Series B.	Series C.
12345	40.	41.1	31.6	120(45)	0.4	0.5	0.3
(12) 345	0.7	0.6	0.7	12_345	0.9	0.6	0.4
123 (45)	12.3	10.5	17.2	${}_10345$	1.1	1.1	2.2
(12) 3 (45)	4.	4.4	5.2	${}_{12}345$	0.6	0.5	2.9
(123) (45)	0.4	0.6	1.9				
1 (2345)	0.	0.	0.5	00300	8.2	8.8	0.2
(12345)	0.4	0.1	0.8	0030_5	0.9	1.	0.1
[123 (45)]	0.	0.	1.3	003_40	0.5	0.5	0.
[(12) 3 (45)]	0.	0.2	0.6				
				00000	4.	2.6	5.
${}_12345$	1.2	0.9	3.1				
${}_123 (45)$	0.3	0.6	1.5	12_x345	0.6	0.4	0.2
10345	6.	6.2	2.5	123_x45	1.1	1.3	0.9
1_2345	3.6	4.	3.7	$123_x (45)$	0.4	0.4	0.7
$1_23 (45)$	0.	0.2	0.5	$(12)\,3_x (45)$	0.3	0.2	0.5
				$(123)_x(45)$	0.2	0.	0.5
12045	1.3	2.	1.2				

Originally each variety was designated by a distinct name. Certain of these names are now used to designate the color of the type, and the banding is expressed by the formula. Thus *petiveria* was fawn and bandless, but the name is now applied

to all shells whose ground color is fawn, and the formula of each is added. Not only in formula, but also in color do the shells intergrade, and the personal equation in nomenclature is large. This, however, affects the deductions from large series but little. Great variation also appears in the width of the bands and to some extent in their color, but these distinctions have not been noted in this paper.

TABLE II. — FREQUENCY OF VARIETIES OCCURRING MORE THAN TWENTY TIMES.

(In percentage.)

	A.	B.	C.	D.		A.	B.	C.	D.
12345	40.	41.1	31.6	47.	12045	1.3	2.	1.2	3.9
123 (45)	12.3	10.5	17.2	14.6	$_{1}0345$	1.1	1.1	2.2	2.
(12) 3 (45)	4.	4.4	5.2	0.2	$_{12}345$	0.6	0.5	2.9	1.3
$_{1}2345$	1.2	0.9	3.1		00300	8.2	8.8	0.2	0.7
10345	6.	6.5	2.5	6.6	00000	4.	2.6	5.	4.6
$1_{2}345$	3.6	4.	3.7	5.9					

"*D*" is a series of 151 shells, sent by Mrs. Brooke to Professor Cockerell, and described in *Science*.[1] While not large, it shows the same general tendency as the other series, resembling "*A*" and "*B*" much more closely than "*C*." It is curious, however, that the series contained but one 00300, as this formula is frequent in Mrs. Brooke's garden. This series resembles "*A*" and "*B*" also in containing quite a number (4.6%) of other varieties than *libellula*.

In summing up Table II, we find that these eleven varieties comprise 82.3% of all the shells in series "*A*," and 82.4% of those in "*B*," but only 75.7% of those in "*C*." They also comprise 86.8% of "*D*." The great *scattering* of the variation is thus shown by the fact that in "*A*" 17.7% of the series contain 102 varieties; in "*B*" 17.6% contain 102 varieties, while in "*C*" 24.3% contain 127 varieties.

These series may be looked at from a somewhat different standpoint, as shown by the following table, in which the varieties are classified. Here the variation of a band may mean that it becomes rudimentary, disappears, or splits. It is doubt-

[1] *Science, loc. cit.*

ful if it be correct to put the splitting and the disappearance in the same category, but every method of classification offers difficulties.

Table III. — Percentage Frequency of Whole Series Classified.

The figures in parenthesis indicate the number of different varieties in each group.

	A.	B.	C.
12345	(1)40.	(1)41.1	(1)31.6
12345, two or more bands fused	(9)18.3	(13)17.1	(22)30.6
Band 1, variable	(2) 1.5	(2) 1.5	(5) 5.1
" 2, "	(6)10.4	(6)11.1	(10) 7.2
" 3, "	(8) 3.2	(16) 4.7	(22) 3.3
" 4, "	(4) 0.3	(2) 0.2	(4) 0.4
" 5, "	(1) 0.1	(4) 0.3	(2) 0.2
Bands[1] 1 and 2, variable	(5) 2.3	(7) 2.1	(7) 5.7
" 1 " 3, "	(1) 0.1	0.	(4) 0.6
" 1 " 5, "	0.	0.	(1) 0.1
" 2 " 3, "	(8) 1.3	(6) 0.9	(3) 0.3
" 2 " 4, "	(1) 0.1	(1) 0.1	(1) 0.1
" 3 " 4, "	0.	(1) 0.1	(1) 0.1
" 3 " 5, "	(1) 0.1	0.	0.
Three bands[2] variable	(9) 0.8	(6) 0.7	(6) 0.9
Four bands[3] variable	(10)10.3	(5)10.5	(2) 0.3
All five bands[4] variable	(3) 4.2	(8) 3.4	(1) 5.
Extra Bands With or Without other Variation.			
$_x12345$	(2) 0.2	0.	(1) 0.1
1_x2345	(1) 0.1	(1) 0.1	0.
12_x345	(6) 1.5	(8) 1.5	(10) 1.8
123_x45	(25) 4.2	(15) 3.4	(30) 5.6
1234_x5	(4) 0.4	(5) 0.4	(1) 0.1
12345_x	(1) 0.1	0.	0.
1_x23_x45	(1) 0.1	(1) 0.1	0.
12_x3_x45	(4) 0.4	(4) 0.4	(6) 0.5
12_x34_x5	0.	(1) 0.1	0.
123_x4_x5	0.	(2) 0.2	0.
$1_x2_x3_x45$	(1) 0.1	0.	0.

[1] Variation in bands 1 and 4, 2 and 5, and 4 and 5 has not been found.

[2] Bands 123, 124, 125, 145, and 245. Single specimens of 234 and 235 variable are also known in the colony, but not in these series.

[3] All with 1245 variable, except two shells of 00005.

[4] Chiefly 00000.

Professor Cockerell has raised the question as to whether the colony, which at first showed a strong tendency to split-band varieties, may not be reverting to the European type, in which the split-band varieties are much less common. From information gathered from data furnished by Major Morrison, he estimates 100 split-band shells in a series of 2200, or about 4.8%. In Mrs. Brooke's list "*D*," the split-band forms are about 4%. In my own series the proportion is in "*A*" 4.4%, in "*B*" 4.1%, in "*C*" 3.4%. A large proportion of the variation in the Lexington colony is along this line. Of varieties previously enumerated, 52 out of 108, or 48%, are split-bands. Of the 277 new varieties listed in this paper, 112, or 40%, show a split band. It is rare to find two split-band shells alike; indeed, among the 134 split-band shells in my three series, no less than 112 different varieties are comprised. It is true that there seems to be a slight diminution in the proportion of split-band shells in the later series, but the diminution is small, and I do not know that Major Morrison's series was intended to be made up impartially. In any case the difference is less than the local difference between series "*A*" and "*C*." In my lists varieties with extra bands (*x* bands) are not counted as split-band. I do not know whether this was the case in Major Morrison's list.

One further table shows very strikingly the divergence of series "*A*" and "*B*" from "*C*."

TABLE IV. — RELATIVE FREQUENCY OF FUSED BANDS.

(By percentage.)

	A.	B.	C.	D.
All bands fused into one	0.4	0.6	3.9	0.
Five banded shells with two or more bands fused	18.3	17.1	30.6	17.9
All varieties with two or more bands fused	23.3	24.7	43.2	22.5

From these facts there are certain conclusions which may be drawn. While the variation is very "scattering," there is a predominance of tendency along certain lines. The most frequent variation is the fusion of bands 4 and 5. Bands 12 and 123 have considerable tendency to fuse, but band 3 rarely fuses with band 4 till all the other bands are fused.

Next to band fusion the most common variation is that of band 2, which varies in 10% of the shells. Band 3 is much less variable; band 1 but slightly variable, except in conjunction with band 2. (In series "*C*," band 1 almost equals band 2 in variability.) Band 4 and band 5 vary very rarely, except when four or all five bands disappear.

In series "*A*" and "*B*" 10% of the shells belong to the group where band 3 alone is left unchanged; these are chiefly 00300, and it is here the variety *rubella* is principally found. The plain shells, or those with only rudiments of bands, run about 4%, and show the chief color variations.

In all the above the tendencies of variation are similar to those in Europe, and the chief varieties are all known in Europe.

More peculiar is the splitting of bands already considered, and the presence of extra bands which cannot be ascribed to any of the common bands. Here the presence of a band between 3 and 4 is most frequent (about 4%), while a band between 2 and 3 is not at all uncommon. Other extra bands are very rare.

As regards variation in different localities, a decided difference is apparent. Little experience is needed to recognize a handful of the shells from Mrs. Moore's garden, their original habitat. The chief differences are three: (*a*) the almost complete absence of any variety except *libellula*. Series "*C*" contains one specimen of var. *rubella* 00300, and Mrs. Moore has in her possession three or four *rubella* 00000, which probably were picked up in her garden. I have seen nothing else from there except *libellula*. (*b*) The almost complete absence of formula 00300, which makes up about 10% in my garden and is very abundant everywhere else. (*c*) The great tendency to fusion of bands, as is shown by Table IV. It should be mentioned that a large proportion of the "*C*" shells seem to have been injured and repaired, and this seems to interfere with the development of band 1, and may account for the higher percentage of variation in band 1 of this series. No reason is apparent why shells from this locality should be more injured than those of other localities, and the injury may be only

apparent. The number of varieties in the "*C*" series is 139, and 113 in each of the other two.

As regards the effect of large destruction of the animals, little difference is apparent in proportions in series "*A*" and "*B*." In 1897 the snails were gathered quite closely, and in 1898 they were far less abundant; indeed, considerable difficulty was realized in completing the series.

In this connection an interesting fact has been communicated to me by Major Morrison. In sending out snails for new colonies, a number of half-grown *bandless* specimens were sent to Blairstown, Pa. This is the only colony which has been heard from and shows a preponderance of *banded* varieties.

This colony gives an interesting example of the results of a tendency to variation in a favorable environment. As far as I have been able to learn, the helix has no enemies. A few broken shells in a hen yard showed that chickens are acquiring a method of getting the animal from the shell. From my experience in collecting the snails, I should not be able to deny a certain apparent tendency to mimicry, if it were asserted; but I should hardly dare assert it. In one locality, quite protected from the light, there seemed to be a preponderance of darker shells and fused bands; among the honeysuckle undergrowth full-banded varieties were more abundant and not easy to see; in more than one locality among yellow leaves, the yellow bandless variety, or 00300, was common. It may have been imagination, but the idea of mimicry suggested itself.

In conclusion, I must acknowledge my indebtedness to Professor Cockerell for all of value there may be in this paper, but exonerate him from all responsibility for its shortcomings.

To this paper is appended a list of all the varieties known in the Lexington colony. Those specimens which have not been previously described in this colony are marked with * and among these, those of which more than one specimen has been found also with †.

WASHINGTON AND LEE UNIVERSITY,
LEXINGTON, VA., August 25, 1898.

Table V. — Varieties of H. Nemoralis Known in the Lexington Colony.

Var. olivaceae, Gassies.
(Olive ground).

*†00300
*00000

Var. aurantia, Ckll.
(Orange ground.)

*†00000

Var. hepatica, Ckll.
(Liver-colored ground.)

*00000

Var. albescens, Moq.
(Whitish ground.)

*†00300
*†00000

Var. purpureotincta, Ckll.
(Very pale purplish ground.)

*1(23)(45)
*†123(45)
*00300
*$123_x(45)$

Var. rubella.
(Pink ground.)

12345
*†123(45)
*†(12)3(45)
*(123)(45)
*†$_12345$
*10345
*†1_2345
*†12045
*120(45)
*†12_345
*$12(_33)45$
*123_345
*123_445
*$_{12}345$
10045
00300
0030_5
*†003_40
*$003_{44}0$
*003_{45}
*$_10300$
*$_{12}300$
00000
*$00(3_3)00$
*$(1_x2)(_33)(45)$
*$(12)_x3(45)$
*123 X 45
*123 X (45)
*123_x45
*$(12)3_x(45)$
*$12_33_{xx}45$
*$12_{3x}(4_4)(5_5)$
*†003_x00
003 X 00
*003_x0_{55}
*$_{122}3_{xx}{}_{44}0$
*12345_x
*12_x3_x45
*$(12)_x3_x(45)$
*12_x34_x5

Var. petiveria.
(Faun ground.)

12345
*†(12)345
123(45)
*†(12)3(45)
*†1(23)(45)
*((12)3)(45)
*(12)(345)
*[12345]
*[1(23) (45)]
*$_12345$
*$_123(45)$
*10345
1_2345
*1(22)345
*1(22)3(45)
12045
*120(45)
*(12)0(45)
12_345
$1(23)_3(45)$
123445
*$_10345$
$_{12}345$
*10_345
*$_12_2045$
00305
*†00300
*†12_x345
*$12_x3(45)$
*$(12)_x3(45)$
*123_x45
*$(12)3_x(45)$
*$(123)_x(45)$
*$1((23)_x(45))$
*$123_{xx}45$
*$(1(22)3_{xx})(45)$
*1034_x5
*$(12)_x3_x(45)$

Var. libellula.
(Yellow ground.)

12345
(12)345
1(23)45
12(34)5
123(45)
(12)3(45)
1(23)(45)

*(123)45
(123)(45)
*†((12)3)(45)
12(345)
*†12(3(45))
*†(12)(3(45))
*†1(2345)
*†1((23)(45))

[12345]
*†[123(45)]
*†[(12)3(45)]
*†[1(23)(45)]
*†[(123)(45)]
*†[((12)3)(45)]
*[(1(23))(45)]
*†[12(3(45))]

02345
$_12345$
*†$_123(45)$
*$(_123)45$
*†$(_123)(45)$
*((11)2)3(45)
$[_12345]$

10345
*†103(45)
1_2345
$1_23(45)$
*$(1_2)3(45)$
*$1_{22}3(45)$
*$1(_{22}3)(45)$
*1_22345
*†12_2345
$1(2_2)345$
$12_23(45)$
*$1(2_2)3(45)$
*$(12_2)3(45)$
*$[(12_2)3(45)]$
1(22)345
1(22)3(45)
*[1223(45)]
*$(122_23)(45)$

12045
*(12)045
*†120(45)
*†(12)0(45)

*Not previously described from this colony.
† More than one specimen found.

$12_{3}45$
*† $12_{3}(45)$
*† $(12)_{3}(45)$
* $[12_{3}45]$
* $[(12)_{3}45]$
*† $(12)_{33}(45)$
*† $12_{3}345$
* $12(_{3}3)45$
$12_{3}3(45)$
* $(12)_{3}3(45)$
* $(12_{3}3)(45)$
$123_{3}45$
*† $12(3_{3})45$
*† $123_{3}(45)$
*† $12(3_{3})(45)$
* $(12)3_{3}(45)$
*† $(12)(3_{3})(45)$
* $(123_{3})(45)$
* $[123_{3}(45)]$
* $[12(3_{3})(45)]$
* $[(12)3_{3}(45)]$
* 123345
$12(33)45$
$1233(45)$
* $12(33)(45)$
* $1(233(45))$
* $[(1(233))(45)]$
$[12_{333}45]$
* $(12)_{3}3_{3}(45)$
* $[12(_{3}3_{3})(45)]$
$1233_{3}45$
$(12)_{3}3(33)3(45)$

* 12305
* $123_{44}5$
$123_{4}45$
$123(_{4}4)5$
$1234_{4}5$
$123(4_{4})5$
$123(44)5$
* $123(445)$
$123(_{44}4)5$
* $123(_{4}4_{4})5$
1234445
$1234_{4}(4445)$

*† $1234(_{5}5)$
* $123(45_{5})$
$1234(55)$

* $123(455)$
*† $123(4(55))$

00345
$003(45)$
* $0_{2}345$
* $0_{2}3(45)$
$0_{22}345$
$_{1}0345$
* $_{1}03(45)$
$_{12}345$
* $(_{12})345$
*† $_{12}3(45)$
*† $(1_{1})0345$
* $1_{1}03(45)$
* $(11)0345$
* $_{1}(2_{2})3(45)$

*† $_{1}2045$
*† $_{1}2_{3}45$
$_{1}23_{3}45$
* $_{1}23_{3}(45)$
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Total varieties enumerated, 385. New varieties enumerated, 277.

New varieties found in more than one specimen, 77.

THE WORK OF THE CONCILIUM BIBLIOGRAPHICUM.

HERBERT HAVILAND FIELD.

Since the foundation of the Concilium Bibliographicum in January, 1896, no notices concerning its work have been sent to the scientific journals, although statements have occasionally been solicited. The reason for this reticence has been the fact that its work has heretofore been rather of the nature of a vast and expensive experiment than of a publication which could stand before the world as an agency able to render fully the services for which it was called into existence.

In this first or experimental stage all have had to bear a share of the burden, and we have reason to be grateful for the patience which our subscribers have shown under these trying circumstances. Liberal as were the donations to the work, they none the less proved insufficient, and the director of the institute has not merely been obliged to work or rather to overwork for three years without a salary, but has been forced to submit to serious financial loss. At present this has been changed, and although the work cannot become remunerative, yet it may now be regarded as definitely assured, thanks to the permanent subsidy voted to it by the Confederation, the Canton, and the Town. It has been placed under the supervision of a joint commission containing representatives of these several interests.

It must not be supposed from this statement that the Concilium is no longer behindhand in its work. Such a change cannot be accomplished in a few days nor in a few weeks. As a fact, however, more cards are now being issued than would correspond to the actual rate of zoological publication, so that we can see our accumulated manuscript growing daily less. When this shall have been entirely disposed of, we shall be able to obtain the proper benefit from the present arrangement of the work.

In the house with the main offices is a specially equipped composing room, where at present three typesetters and a head typographer give their entire time to the Bureau. In a neighboring building the large cylinder press has been set up, as well as a paper-cutting machine in charge of a special machinist. With this staff of employees, we are able to print and issue nearly 100 different cards a day. For sorting the cards a double check system is used, which makes errors almost impossible.

In regard to classing the cards, we were at first inclined to consider this of secondary importance, the arrangement being the concern of the user. We have found, however, that such a course would be simply disastrous. The entire bibliography is a structure growing by internal additions, as an animal or a plant does. Consequently, every element must have a definite destination. For a catalogue of current literature in pamphlet form such a chapter heading as Fauna of the Celebees would be far too detailed ; not so for a great catalogue destined to receive the contributions of many years. Indeed, we go much further and arrange the papers on the Celebees according to the animals dealt with. Thus there is a place reserved for the Lizards of Celebees ; possibly there are already cards at that place, possibly some will be added in the coming year.

It is obvious that our central catalogue can be arranged with such detail ; but how can we duplicate such a catalogue in the hands of our subscribers ? With such an overwhelming number of divisions, how can one find Celebees ? In a book one can have an index with references to the pages ; can one not apply a similar system to cards by numbering the places in which cards may be entered ? It is evident that such a course is perfectly practicable, and it is this that we have done with the single modification that we have preferred to choose such numbers as would permit us to enlarge our scheme at will. It is needless to explain how this last requisite has been reached. In the past such explanations have been given and have only served to render complicated a very simple matter. It is not at all necessary to understand how logarithms are calculated to use a table for a definite mathematical problem, and so it is with our numbers.

If one is desirous of knowing what has been published in regard to Faunæ, one has only to look in the index to see that they are dealt with in section No. 19. If one is interested in the Celebees one can find them at division 19 (912). People talk of these numbers as if we expected them to be learned by heart, or as if they were intended to convey information by a sort of symbolism. They are not one iota more complicated than the page references in any book index, after one has learned that the numbers are read successively from left to right, so that all numbers beginning with 1 (19, for instance) come before 2, etc. Personally I see no reason for regarding section No. 78, in which we have Anura, as in any sense more complicated as a number than section 435, where they stand in Leunis. Neither does it seem to me too mathematical even for zoologists having an "aversion to numbers." The system is a purely practical device and is not affected by idle talk about the theoretical unsoundness of classifying by groups of tens. Equally irrelevant is the remark that our classification is not scientific. We know it is not, and we often regret that it is not less scientific. I am well aware that the system we use follows the scientific separation of Reptiles from Batrachians ; bibliographically, this is of doubtful advantage, and the practical bibliographer often wishes he had some common ground where he could place Herpetology, before entering in upon works dealing with each group by itself. Not until people cease being specialists in regard to both Amphibians and Reptiles will the need for a common division also disappear.

For purposes of subscription almost any conceivable topic will be received, no matter how restricted it may be, the price varying from one-fifth of a cent to one cent a card, according to the size of the order. Innumerable sets cost from ten to twenty cents. Such prices have been fixed in order to establish relations, if possible, with the whole body of zoologists. It seems as if under such conditions 500 subscribers ought to be possible in the United States alone.

The complete series are designed rather for libraries, museums, and laboratories. In our opinion every scientific center should have at least one such set. In the United States, how-

ever, this is far from being the case. Thus, in New England, Williams College has the only such set. On the Atlantic seaboard such orders have been further received from Columbia, Cornell, Pennsylvania, and Princeton. Minnesota has two such ; Iowa and Illinois each one. The more restricted set, in which each paper figures but once, usually in the systematic part, has a far wider circulation. Nine sets go to Massachusetts, one to Rhode Island, a number to the Washington departments, two to Ohio, and one each to Indiana, Michigan, Wisconsin, Minnesota, Iowa, and Kansas. As will be seen from this summary, there are still districts where no complete set can be seen. This is a pity, since we are rapidly nearing the time when no more back sets will be available.[1]

In regard to the anatomical and physiological bibliographies, it may be said that they too are nearly ready to be pushed, as is now being done for the zoological portion. A delay took place in consequence of a rupture with our former printer, so that in order to issue the book edition of the *Bibliographia Physiologica* we were obliged to set the entire work a second time. This has been done and we can now return to the cards.

In order to facilitate relations with the United States, Mr. Edward S. Field, of 80 Leonard Street, New York, has been authorized to receive subscriptions. A large number of descriptive circulars will be deposited in his office and may be had on application.

[1] South America has given us many complete orders, as also Hawaii.

ON PROTOSTEGA, THE SYSTEMATIC POSITION OF DERMOCHELYS, AND THE MORPHOGENY OF THE CHELONIAN CARAPACE AND PLASTRON.

O. P. HAY.

THE structure and relationships of the genus of fossil turtles known as Protostega are being gradually determined. Important additions to our knowledge regarding it have been made recently by Dr. E. C. Case[1] and Mr. G. R. Wieland.[2] The former describes and figures in an excellent way the plastron, the skull, the shoulder girdle, and the limbs ; and discusses at length the relationships to the other Testudines. Mr. Wieland supplies needed information regarding the ribs and the existence of neuralia. He regards the form which he describes as a new genus, which he calls Archelon, but it will be generally agreed, I think, that it is not distinct from Protostega.

One of the most important discoveries made by Case is the arrangement of the xiphiplastrals. When I wrote my paper[3] on the portion of the plastron of this animal then in my hands, I assumed that the xiphiplastrals had essentially the same form and dimensions as in the modern genus Thalassochelys. Case finds that, on the contrary, immediately after these plastral elements have freed themselves from the hypoplastrals they sharply curve toward the mid-line and come into contact. The length of the plastron is thus much reduced. Dr. Case also concludes that the epiplastrals must have been much shorter than they are in Thalassochelys, and that the entoplastron was probably wanting. From this condition of the plastron Case concludes that my estimate of the size of Protostega was much

[1] *Journ. of Morphology*, vol. xiv, pp. 21–55, Pls. IV–VI.
[2] *Amer. Journ. Science* [4], vol. ii, pp. 399–412, Pl. VI, and 19 text-figures.
[3] *Field Columbian Museum Pubs.*, *Zoology*, vol. i, pp. 57–62, Pls. IV, V.

too great, his own calculation making the total length 2.273 meters, as against my own estimate of 3.92 meters — a very considerable difference.

However, I do not believe that Case's conclusion necessarily follows from his premises. My estimate was primarily based on the distance from the bottom of the excavation in the hypoplastron for the fore limb to the excavation in the hypoplastron for the hind limb. It seems to me highly probable that these borders of the plastron could not have approached the corresponding limbs of Protostega more closely than they do in Thalassochelys and yet leave the limbs free to make their movements. The limbs, then, must have been as far apart as they would be in a Thalassochelys whose plastron had the corresponding measure equal. Hence any shortening of the body must have been effected in front of the fore limb and behind the posterior limbs. This would necessitate the shortening of the anterior dorsal and the anterior caudal vertebræ; and of this we have no proof. The dimensions of the various plastral elements are extremely variable in the various genera of turtles; and it hardly follows that, because the xiphiplastrals are very short, the body of the animal is correspondingly curtailed. The estimate of the length made by Wieland, based on his apparently quite perfect carapace, is not greatly less than my own estimate.

I wish here to make a remark on the genus Atlantochelys of Agassiz. It has been thought that it is identical with Protostega of Cope; but a comparison of Leidy's figure[1] of the humerus, on which the name was based with that of Protostega, shows that the two genera are very distinct. The humerus of Atlantochelys contracts below the tuberosities into a much more slender shaft than does Protostega. The humerus of *Atlantochelys mortoni* resembles not distantly that of Lytoloma, as figured by Dollo.[2]

It was the judgment of Baur,[3] also, that Atlantochelys is different from Protostega. Cope's *P. neptunia* is merely a

[1] *Cretaceous Reptiles, U. S.*, Pl. VIII, Figs. 3–5.

[2] *Geol. Mag.* [3], vol. v, p. 266.

[3] *Biolog. Centralblatt*, Bd. ix, p. 189.

synonym of *Atlantochelys mortoni*, the latter name dating from time of Leidy's figure and description, 1865.

In his discussion of the relationships of Protostega to the other Testudines, Case succeeds completely, in my estimation, in proving that the genus under consideration belongs near the Cheloniidæ. Many authors have assigned to it definitely a position among the Dermochelyidæ ; but this disposition of it was doubtless due to Cope's error in regarding the plastral plates as portions of the carapace.

Case also endeavors to prove that Protostega is not distantly related to Dermochelys ; that it is, in fact, "a distinctly intermediate form" between Dermochelys and the Cheloniidæ. Dermochelys is, therefore, not worthy of being made the foundation of a distinct suborder, the Athecæ of Cope, but is a member of the superfamily Chelonioidea.

As anatomists are aware, the late Dr. Baur strenuously opposed the proposal to remove Dermochelys far from the company of the other sea turtles. Like Dr. Case, he regarded it as having been derived from the Cheloniidæ, differing from the others in having become more highly specialized for aquatic life.

Baur's arguments had evident effect on his antagonists ; and it will doubtless be admitted by all that he and Case have valiantly defended their position. Now that Protostega has been definitely shown to belong near the Cheloniidæ, many will, no doubt, be inclined to believe that the defended position is unassailable. Notwithstanding all this, I have not been able to divest myself of the feeling that Dermochelys is not to be admitted into the same suborder as the other living sea turtles. And here I recall the words of Van Bemmelen, who felt strongly the force of the arguments employed by the opponents of Baur, but found himself compelled to accept the views of the latter.

As regards Protostega, it appears to me that Case's investigations show conclusively that it has no special relationships to Dermochelys. It is in no important sense an intermediate form; and Case has not so regarded it in his scheme showing lines of descent.

I shall not enter into any extended discussion of those structures which Dermochelys possesses in common with the other sea turtles. Most of them have already received consideration from Baur, Dollo, Boulenger, Van Bemmelen, and Case. Some of these common characters may be attributed to inheritance from a common remote ancestor; such are, for illustration, the wide separation of the pterygoids seen in both Protostega and Dermochelys, and the roofed-in condition of the temporal region found in Dermochelys and the Cheloniidæ. Other characters possessed in common may be due to convergence, resulting from similarity of habits, movements, etc. I would include in this category the presence of an articulation between the eighth cervical and the nuchal, the plane surfaces of articulation between the sixth and seventh cervicals, and the more or less reduced condition of the carapace and plastron. Probably the surfaces joining the sixth and seventh cervicals are plane for the same reason that they are plane between the various dorsal vertebræ; namely, this articulation is one situated where there is only slight movement, lying, as it does, between two curves in opposite directions.

But whatever may be the conclusions reached concerning the other points in the anatomy of Dermochelys, its singular dorsal and ventral shields form one of the most striking characters of the animal, the one about which there has been the most contention, and the one which probably furnishes the key to the situation. The condition and mode of origin of this carapace were the most difficult matters for Baur to explain; and regarding its morphogeny he changed his mind more than once. At the time the discussion was going on between himself and Dollo and Boulenger, Baur took the position that the carapace of Dermochelys had been derived from that of its Chelonioid ancestors through delamination of the layer of membrane bone from the ribs, and the dissolution of this into polygonal pieces. Later he came to the conclusion that the membrane bone of the carapace of Dermochelys had become wholly, or nearly wholly, reduced, and that the layer of mosaic-like pieces was of secondary origin, an entirely new development. Case adopts this later expressed opinion.

This view, however, is not without difficulties of its own. Dollo and Seeley have both referred to the fact that the dermal plastron of Dermochelys is not complete ; that is, the bony mosaic is deficient in the spaces between the longitudinal keels of the plastron. Shall we now regard this condition as a stage on the way toward a complete plastron ; or shall we hold that the complete plastron was once possessed and that the present condition was due to reduction ? The former way of looking at the matter is opposed to the fact that Dollo and Seeley concluded that Psephophorus, a close ally of Dermochelys, living in the Miocene, possessed a continuous plastron of mosaic-like pieces. If the latter view is held, we might properly inquire how it happens that nature is so vacillating regarding the needs of this animal.

We may well doubt, too, that there has been sufficient time granted the Dermochelyidæ in which to effect the change in their armor. Case derives the family from Lytoloma, of the upper Cretaceous and lower Eocene ; but both Eosphargis and Psephophorus had appeared already in the Eocene. This implies rapid modifications of structure. On the other hand, it is evident that changes go on in the turtles very slowly. How much progress in the reduction of the carapace and plastron, for instance, has been effected in the Cheloniidæ since Cretaceous times ?

A difficulty affecting not only Baur's later view, but also the earlier one, is experienced in endeavoring to understand what advantage Dermochelys has gained over the alleged old-fashioned turtles by undergoing its various supposed adaptive changes. The thecophore sea turtles are more numerous in genera, species, and individuals than the Athecæ, notwithstanding the fact that the former have been relentlessly pursued for their flesh, their shell, and their eggs. As an ancient, intractable form, with difficulty adapting itself to its environment, we can understand Dermochelys.

Seeley[1] has felt the necessity of accounting for the origin of the armor of turtles in a way different from that usually adopted. He thought that a portion of the carapace had its

[1] *Quar. Journ. Geol. Soc.*, vol. xxxvi, p. 410. London, 1880.

origin in bone developed, not in, but beneath the skin ; and he suggested that the uncinate processes of the ribs of the crocodiles and birds might afford a clue to the solution of the problem. However, these uncinate processes are of cartilaginous origin, while the bony plates which constitute the greater portion of the carapace are of membranous origin.

We must recognize, at least in the Amniota, besides the bones developed from a basis of cartilage, two kinds of membrane bone. One of these is developed within the external integument itself ; the other in the fasciæ, beneath the skin. Examples of the first kind, or true dermal bones, may be found in the osteodermal plates which occur in the scales of the Scincidæ and of some other lizards. Such, too, are the pieces which form the mosaic armor of Dermochelys. Examples of the second kind of bones, or fascia bones, are furnished by the so-called abdominal ribs of Sphenodon. Of course the two kinds may often coalesce with each other or with cartilage bones.

In the abdomen of the cayman both strata of bones occur. There is a set of abdominal ribs developed in the subcutaneous fascia, while in the skin itself there is a system of bony scutes which constitute a ventral armor. Sphenodon likewise possesses a system of abdominal ribs, which are wholly independent of the true ribs ; but there is no dermal armor. If bony plates were developed in the ventral scales of Sphenodon, we would find two strata of bones, as in the cayman.

The abdominal ribs of Sphenodon, then, are homologous with those of the cayman, and not with the latter's dermal armor. It is generally agreed that most of the plastral bones of the turtles find their equivalents in the abdominal ribs of Sphenodon, not in the dermal armor of the cayman. The epiplastra and the entoplastron of the Testudines are doubtless the homologues of the clavicle and the interclavicle of other reptiles and of the Stegocephali, and belong to the same stratum of bone as the abdominal ribs.

Now it seems to me almost certain that the marginal bones of turtles have had the same origin as the bones of the plastron ; that is, they are not dermal bones, but fascia bones. Further-

more, I see no reason why we may not regard the nuchal bone and those plates of bone which have united with the neural spines to form the neuralia, and with the ribs to form the costalia, as having originated in the same way. Two strata of bones might as reasonably be expected to occur on the dorsal region of the body as on the ventral. In accounting for the condition of the carapaces of modern turtles, we may suppose that the earliest ancestors of turtles had a scaly skin, which contained osteodermal plates.[1] Beneath these there were developed first, perhaps, in the fascia of the shoulders, a nuchal bone, later other plates which in time became transformed into the neuralia and costalia. As these deeper-seated fascia bones increased in importance, the osteodermal plates underwent gradual reduction. Only in Dermochelys have they maintained anything like their early importance. As regards the deeper layer of bones even in this turtle, the ribs, flattened, and with jagged edges, seem to me to indicate that at some time in the remote past there have been costal plates of membrane bone fused with them.

Can we find any evidences bearing on the hypothesis proposed?

In Vol. iv of the *University Geological Survey of Kansas*, pp. 370 *et seq.*, Case has described and given figures of three species of the genus Toxochelys, not uncommon turtles of the upper Cretaceous deposits of Kansas. While working in Dr. Baur's laboratory in the University of Chicago, I had the privilege of studying and of making drawings of the specimen of *T. serrifer*, which Case has presented on his Pl. LXXXIII. This specimen is the property of the paleontological department of the University of Kansas, now in charge of Dr. S. W. Williston. One of the most interesting observations that resulted, one that has often been recalled to mind, was that there was evidently a series of separate bones along the middle of the back, lying across certain of the articulations between neurals.

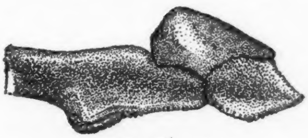

FIG. 1. × 1.

[1] Baur, G. *Biol. Centralblatt*, Bd. ix, p. 182; *Sci.*, vol. xi, p. 144.

Case has figured one of them and referred to it in his description on page 382. He has, however, scarcely done it justice when he refers to it as a thin ossicle. Fig. 1, here presented, gives a lateral view of this ossicle and of the seventh and eighth neuralia on which it rests. The figure is of the size of the object.

The drawing that I made of the carapace, seen from above, is slightly different from that of Dr. Case, and I here reproduce such part of it as pertains to the bones involved (Fig. 2), one-half natural size. It is my opinion that Case has made the fifth and sixth neuralia exchange places in his drawing. My reasons for so thinking are these: On the anterior end of neural 7 of Case's figure (9, according to his notation) there is an excavation that is not filled up as he has placed the bones; while as I have placed them, this excavation is accurately filled by a process from my neural 6. Again, Toxochelys evidently had, like its relatives, Thalassochelys and Chelydra, a system of epidermal scutes. Now, in these last-named genera, and in the great majority of other turtles, the suture impressions of these scutes cross the first, third, fifth, and eighth neuralia. The exceptions are rare. According to Owens's[1] figure, the suture between the fourth and fifth scute passes across behind the eighth neural. Now, as I have arranged the neuralia, the dermal sutures are in their proper places. Another suture would probably cross just behind the ossicle lying across the suture, between neuralia 7 and 8.

FIG. 2. × ½.

At the anterior end of neural 5 there is an excavation which had evidently served for the reception of an ossicle like the one across neurals 7 and 8; and in the collection there was then a bone like the ossicle referred to, and it quite accurately fitted the excavated surface. At that time there was no doubt that those bones belonged as they were drawn. There was also in the collection another bone, which I have figured as the

[1] Owen. *Anat. Vert.*, vol. i, p. 61.

third neural. It has, as it should have, an epidermal sutural impression across it. On the anterior end of this bone there was present a prominent tubercle, which in form and position resembled the distinct ossicles further behind; but there was no suture at its base. The conclusion drawn was that it was once distinct but had become coössified with the underlying neural.

Fig. 3 represents, of actual size, another bone that was found in the same collection of Toxochelys materials. Its upper portion resembled closely one of the ossicles described above; but below this there was a thinner portion, which had evidently been buried in the flesh. It was regarded as equivalent to one of the rows of bones which are to be found along the upper edge of the tail of Chelydra.

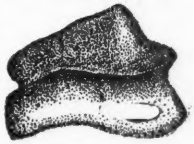

FIG. 3. × 1.

It seems to me evident, therefore, that that row of tubercular ossicles along the back of Toxochelys was simply a continuation forward of the row that, like those of Chelydra, must have been present on the tail. These last must be reckoned as of purely dermal origin; so, too, must those on the carapace. Moreover, the neuralia on which they were reposing must belong to a deeper stratum of bone.

A median keel along the back is a not uncommon feature of turtles. Nearly all species possess it at an early stage of life; although it may become obsolete as growth proceeds. In some tortoises this keel is elevated at intervals into prominent tubercles. These occur near the hinder border of each of the median bony scutes. *And that is just where those tubercle-like ossicles of Toxochelys were found.* I conclude, therefore, that these dorsal tubercles of our existing turtles have originated from a median dorsal row of dermal bones, distinct in the earlier forms, but now ossifying continuously with the underlying neurals. In the young of the diamond-back terrapin (*Malaclemys terrapin*) these dorsal tubercles are greatly developed and consist of four or five globular masses like small peas. It would be interesting to have their development studied, in order to ascertain if possibly they may yet possess distinct centres of ossification.

If we examine the carapace of a specimen of Dermochelys, or, in lieu thereof, the plates presented by Gervais,[1] we shall find that along the mid-line of the dorsal surface there is a row of enlarged bony plates, each bearing on its upper surface a prominent ridge. If we suppose that the early ancestors of our common turtles had at once a carapace like that of Dermochelys and a more or less rudimentary carapace of the common kind, it will be easy to comprehend that, as the dermal carapace underwent reduction, some of the larger median plates remained behind, first as independent ossicles, then as mere knobs on the neuralia.

A further examination of the test of Dermochelys proves that on the upper surface there are six more keels, three on each side. The third keel on each side, reckoning from the mid-line, forms the margin of the carapace; the two others are between it and the median keel. Each of these ridges, or keels, is composed of polygonal bony plates considerably larger than those occupying the spaces between the keels.

In a considerable number of species of turtles there are to be found on the carapace three keels, a median and two lateral. The lateral keels, although usually not so prominent as the median keel, are sometimes quite as well developed, and are occasionally conspicuously tuberculated. The median and the lateral keels are to be seen in young individuals of the snapper (Chelydra), and are strikingly displayed in large specimens of the alligator snapper (Macroclemys). In the latter species the tubercles are very large and projecting. Other tricarinate species are *Staurotypus triporcatus*,[2] *Damonia reevesii*,[3] and *Nicoria trijuga*.[4] These lateral keels occupy exactly the position held by the first pair of lateral keels of the carapace of Dermochelys; and it seems to me entirely probable that they have been inherited from a common ancestor, and have been produced from rows of distinct ossicles, as the middle keel has.

A search among various genera of thecophore turtles for traces of the second pair of lateral keels, as seen in Dermo-

[1] *Nouv. Archives du Museum*, vol. viii (1872), Pl. IX.
[2] Gray. *Catalogue Shield Reptiles*, pt. i, Pl. XX B.
[3] *Op. cit.*, Pl. V.
[4] *Op. cit.*, Pl. IV.

chelys, was less fruitful; and I had about concluded that all vestiges of them had vanished. Finally, however, I was led to examine more closely the carapace of Macroclemys. These turtles alone among all living forms, so far as I know, possess a row of three or four epidermal scutes lying along each side between the costal scutes and the marginals. They are known as supramarginals. Each of these areas is lifted up into a rounded knob somewhat like the tubercles of the keels higher up. This row of knobs I regard as the last remaining vestiges in the Thecophora, of the second pair of keels of the ancestral turtle. This pair of keels in Dermochelys may properly be called the supramarginal keels.

As to the third pair of lateral keels, they have probably left traces of themselves in the serrations that mark the margins of the carapace of many turtles, more especially the posterior margins.

The ventral surface of Dermochelys is provided with five keels, two lateral on each side and a median. The two lateral pairs are most conspicuously developed in a young Dermochelys recently hatched. These keels, both dorsal and ventral, may be of some use in swimming, in maintaining the body in a direct course; but the adults of other sea turtles are without more than the merest traces of them. Nevertheless, some of the ventral keels are well developed in the young of the marine turtles. In a young Thalassochelys[1] the first pair of lateral keels runs along the middle of the hyo- and hypoplastral bones, and these keels are conspicuously tuberculated. In the same individual the keels of the second pair are seen to run along the rows of inframarginals and are also tuberculated. Relatively few turtles possess inframarginals, and it was the finding of the lateral keels in Thalassochelys that suggested to me an examination of the supramarginals of Macroclemys in my search for traces of the corresponding keels on the upper surface of the body.

The plastron of Toxochelys possesses on each side a low but sharply defined keel, which corresponds to one of the first pair of Dermochelys. It is represented in Case's figure. We should

[1] Agassiz, A. *Cont. Nat. Hist., N. A.*, vol. ii, Pl. V, Figs. 14–16.

hardly expect a huge sea turtle like Protostega to possess a pair of plastral keels; but that such were present may be seen from the examination of my figures of this plastron.[1] A few turtles which are fitted for existence on the land also have these keels. They may be seen in Gray's figures of *Kachuga lineata* and *K. dhongoka*.[2] I find no tubercles that furnish evidences of remains of the median ventral keel in any turtles except Dermochelys. This keel appears to have quite completely vanished. I shall, however, return to a consideration of it. All the keels, as we now find them in the Thecophora, I look upon as having originated through the fusion of rows of distinct dermal ossicles with the underlying bones of the carapace and plastron.

The presence, in turtles of so many and so widely removed families, of these keels and rudiments thereof, always more or less tuberculated at an early stage of life, is rendered comprehensible if we once admit that the common ancestors of the groups possessed corresponding rows of tuberculated bones. On the other hand, the possession of these numerous keels by Dermochelys is, we might say, incomprehensible if we are to suppose that it took its origin from a race of sea turtles that had completely, or nearly completely, lost the carapace and plastron. If the structure of the new carapace had anything to do with that of the old one, and if the keels of the superior second lateral pair were really associated with the supramarginal scutes, how could these keels have reappeared in Dermochelys if this were derived from a stock which had no supramarginals or supramarginal keels? If the disposition of the new carapace had nothing to do with that of the old, how came it that we can seem to find such close correspondences? Dermochelys would offer a most remarkable case of convergence or reversion.

One of the most remarkable facts about turtles is the want of correspondence between the horny scutes of the carapace and plastron and the bones which underlie them. When osteodermal plates are developed in the crocodiles and lizards, they are overlain by corresponding horny scutes. In tortoises, on the contrary, each lateral horny scute of the carapace covers a

[1] *Field Columbian Museum Pubs., Zool.*, vol. i, Pls IV, V.
[2] *Catalogue Shield Reptiles*, pt. i, Pls. XVII, XVIII.

costal plate, the half of the plate next in front, and the half of the plate next behind. The neural scutes are similarly disposed, covering sometimes wholes or parts of from two to four neurals. The marginal scutes are only as long as the marginal bones which they cover; but, instead of coinciding with the latter, they "break joints" with them. Neither do the plastral scutes coincide with the bones of the plastron. It is evident that the scutes have had a development wholly independent of the bones beneath them. How has this occurred?

The skin of the adult Dermochelys is wholly devoid of division into areas resembling scales or scutes; but in the young, a fine specimen of which I have been permitted to examine in the National Museum, the skin is everywhere, on body and limbs, broken up into small polygonal areas. Along the dorsal and ventral keels these areas are considerably larger than elsewhere. It is quite certain that these areas coincide with the osteodermal plates which are, or will be, developed in the skin. When the bony plates have increased in size, the overlying scute has become correspondingly extended.

I conclude, therefore, that the earliest turtles were covered with numerous small horny scales, possibly overlapping like those of lizards; and that in the dermis beneath these scales there were produced osteodermal plates. From such an ancestor, land-inhabiting, and having limbs fitted for such a life, there arose a race that has culminated in our leather-back turtle. This race early betook itself to an aquatic life, and its limbs suffered profound modifications. Possibly also the epidermal structures and the underlying bony plates became more or less modified. Quite certainly the deeper carapace and plastron underwent considerable reduction. The nuchal bone, however, remains to the present day.

From the same primitive ancestors that gave birth to this athecate tribe there arose another vigorous race, whose members tarried longer on land. In the members of this branch of the Testudines the elements of the more deeply developed shield were probably present, but in a somewhat rudimentary state. To such an animal, with probably a broad and inflexible body, slow of movement, and with few defenses, it would have

been advantageous to have a more resistant armor than that afforded by a layer of small articulated dermal bones. Fewer and larger bones, resting on and perhaps breaking joints with the as yet perhaps rather indifferently developed fascia bones, would have rendered the shield less vulnerable. It was only natural that the osteodermal plates of the already present keels, and indeed only a few of these plates, should grow at the expense of the smaller surrounding plates. As these few plates extended themselves at their base, they rose above the surface in the form of tubercles or spines. Possibly it was their function as spines that determined their growth. The result was finally, as I view the matter now, that one of these plates, with its correspondingly extended epidermal scute, occupied most of the space now covered by each of the scutes of our living turtles. At length the deeper elements of the carapace and plastron attained such a stage of development that the dermal bones were of small service, and they began to undergo reduction; but this reduction did not necessarily interfere with the subsequent growth of the epidermal scute. In some cases the extirpation of outlying isolated patches of horny epidermis is not yet complete, as may be seen on the plastron of Chelydra. As already suggested, not only have the keels disappeared from many turtles, but in many cases even the epidermal scutes, which became associated with the ossicles of those keels. The supramarginals have disappeared from all except Macroclemys. The Cheloniidæ possess inframarginals; so, too, does Dermatemys. *Staurotypus triporcatus*[1] has a row of only two inframarginal scutes lying across its shortened bridge. In most genera the pectoral and abdominal scutes have come into contact with the marginals. There are, then, often found at each side of the bridge a scute, the axillary and the inguinal. These are doubtless vestiges of the inframarginal keels.

That the epidermal scutes have originally taken their start from the individual tubercles of the various keels, may be seen on examination of the scutes in almost any of our turtles, more especially the lower forms, Chelydra, Malaclemys, etc. In the

[1] Gray. *Catalogue Shield Reptiles*, pt. i, Pl. XX B.

neural scutes the lines of growth show that the tubercle at the posterior border is the starting point; and from there the scute spreads mostly forward and laterally. In the costal scutes the growth begins near the upper hinder angle and spreads downward and forward. If there is a lateral keel, its tubercles form the starting point. From these the scutes have spread toward the marginals, and between the former and the latter the supramarginals have been suppressed. It might be supposed that the manner in which the epidermal scutes extend themselves is determined by the growth of the underlying bones; but a study of the relations of the two sets of structures will, I think, disprove this idea. These scutes are simply following the course laid down by their predecessors. In some of the higher turtles, as species of Testudo, the centre of growth, the areola, of some of the scutes has moved nearer the centre of the scute.

The great scutes of the plastron all grow from a point near the posterior outer angle forward and toward the mid-line where they have met. In doing this they have suppressed the scutes of the middle keel. To a less extent they have grown upward and forward, and have thereby suppressed partially or wholly the inframarginals.

If the reader will examine the figures on Pls. XXII–XXV, of Gray's *Catalogue of Shield Reptiles*, Pt. i, and Pl. VI of Boulenger's *Catalogue of Chelonians*, he will find a large scute on the mid-line of the plastron of each of the turtles there depicted, near the anterior end, and, except on Pl. XXIII, surrounded by other scutes. This is the intergular. It occupies the position where the median and first pair of lateral keels of Dermochelys come together. Indeed, it is located rather on the territory where the median keel would end anteriorly. Its lines of growth show that it spreads from a central point in all directions. This intergular has very much the appearance of having originated from the median plastral keel. Usually the intergular extends forward to the anterior margin of the plastron and is smaller, as in Gray's *Catalogue*, Pls. XXVII, XXVIII (*Podocnemis*). In such cases it less forcibly suggests an origin from the median keel, and has evidently undergone great reduction.

An inspection of the plastron of the alligator snapper (Macroclemys), or of the figures on page 26 of Boulenger's *Catalogue of Chelonians*, shows that in this genus there is sometimes present an intergular shield. This remarkable turtle, then, has vertebral, costal, supramarginal, marginal, and inframarginal shields, a row consisting of the usual plastral shields, and occasionally an intergular, that is, *rows of epidermal shields representing all twelve of the longitudinal keels of Dermochelys and, as I believe, of the ancestors of all the groups of turtles.* So far as I know, there is no other turtle which shows all these. The marine turtles are not far behind, since they present traces of all the keels, except the supramarginals.

The number of epidermal shields and of the hypothetical osteodermal plates belonging to each keel of the thecophorous turtles is, of course, much smaller than in Dermochelys, about one in each keel of the carapace for two vertebræ and pairs of ribs. An examination of the bony plates which form the armor of the sturgeon reveals some characters in common with those which we suppose once belonged to the turtles. They are broad-based, rise into a backwardly directed spine, and in number are about one-half as many as the ribs and vertebræ which underlie them. On the tail of Chelydra, a cousin of Toxochelys, the dermal bones which produce the serrations of that tail fall in number considerably below the vertebræ on which they rest.

Reflection on the early state of the Chelonian armor has led me to study the condition of corresponding structures in Sphenodon, that reptile whose position lies so close to the base of the reptilian stem.

Many reptiles, as is well known, possess longitudinal rows of enlarged scales, especially one which forms a crest along the dorsal mid-line ; and it occurred to me that possibly Sphenodon would show not only this but traces of other keels. What I find is as follows : On the dorsum of the tail there is a row of quite large horny tubercles, which resemble quite closely those seen on the tail of Chelydra. In none of them, however, do I find ossifications.[1] If any such have ever been present, they

[1] Günther, A. *Philos. Trans. Roy. Soc.*, vol. clvii (1867).

vanished long ago. Lvoff, however, states[1] that he has found minute ossifications in the teeth of the crest of Sphenodon. This row of tubercles is continued forward to the head, with one or two interruptions, by a series of thin horny plates.

On each side of the tail are evidences of two other keels. Of these, the upper appears to occupy the position of the costal keel of the turtles ; the other the position of the marginal keels. On the trunk I find no satisfactory evidences of the existence of lateral keels, although there are some scattered enlarged scales. On the rump I find a rather interesting thing, although it may have no significance. On each side is a row of pointed scales, about six in number, which begins near the upper end of the ilium and runs backward and toward the median crest. These two rows of scales suggest the hinder borders of the carapace of Dermochelys.

A dissection of the tail of Sphenodon proves that there is just one horny tubercle on its dorsum for each neural spine. Between the bases of adjacent tubercles folds begin and run downward on each side across the tail; on the under side of the tail there are, between the successive folds mentioned, two transverse rows of enlarged scales. On the sides of the tail the epidermal scales are much smaller and more numerous.

On the belly the epidermal scales resemble those found on the under side of the tail. On the side of the trunk they are again very small. A careful reflection of the skin of the belly brings to light the "abdominal ribs," or gastralia, as they have been called by Baur. Immediately behind the sternum the skin is loosely attached to them ; but along most of the belly it is closely adherent. There are about twenty-five of these gastralia.[2] Each may be said to resemble a very open capital V, with the apex directed forward. Each consists of three closely united bones ; one forming the apex of the V and a portion of its sides, the other two forming the extremities of the sides of the V. Now, there is a cross row of epidermal scales for each of these gastralia, and two of the latter for each pair of ribs. In fact, the lower ends of the ribs are attached to alternate

[1] Lvoff, W. *Bull. Soc. Imp. Natur. Moscou*, vol. lx, pt. ii, p. 333.

[2] Günther, A., *loc. cit.*

gastralia. In crocodiles the gastralia are only equal in number to the pairs of ribs in the same region of the body. The cross rows of epidermal scutes also equal the ribs in number, but they do not follow the direction taken by the gastralia, as they do approximately in Sphenodon. In snakes the rows of epidermal scales equal the ribs. In general, a study of the scales of reptiles would, I think, show that originally, at least, there has been some simple numerical ratio between the segments of the body and the number of gastralia and epidermal scales.

Gastralia of the form described have occurred not rarely in the vertebrates of past ages. They occurred in Archegosaurus and other genera among the Stegocephali, and in the Ichthyosauria, the Sauropterygia, and the Pterosauria among the extinct reptiles. Being so widely distributed among the early reptiles, some of the latter showing relationships in some respects with turtles, it is very probable that the ancestors of the latter possessed similar gastralia. Whether there were several of these for each pair of ribs, as was the case with the Stegocephali, or two, as in Sphenodon, or one, as in Ichthyosaurus, we cannot tell.

Assuming that the plastron of turtles has had its origin in such gastralia, it would be interesting to know how many of these have been concerned in its construction. From the great length of the plastron in most turtles, and the slender form of the gastralia, we might at first suppose that many were involved ; but this, I think, would be an erroneous conclusion. We must recollect that turtles possess only ten dorsal and no lumbar vertebræ. Hence not more gastralia can be included than those corresponding to ten pairs of ribs ; indeed, not so many.

The umbilicus in young turtles is placed where the suture between the hyoplastra and hypoplastra crosses the mid-line ; hence this suture is an approximately fixed line. It corresponds pretty closely to the suture between the fourth and the fifth ribs. Therefore, four pairs of ribs belong in front of it ; six pairs behind it. Of the four pairs in front of these sutures, we must, it seems likely, concede that at least two originally were connected with the sternum below, and hence would not

have corresponding gastralia. There could then not have been more gastralia than would correspond to two pairs of ribs. Excluding the entoplastron and epiplastra, which originated otherwise, we have in front of the umbilicus, in most turtles, a single pair of plastral elements, the hyoplastra. But it is evident that in the earliest turtles there was an additional pair, the mesoplastrals. They are present in some living Pleurodira. In the genus Sternothærus[1] the mesoplastrals extend right across the plastron, and meet in the mid-line. In Pelomedusa[2] and Podocnemis[3] they are reduced to the condition of wedge-shaped plates lying on the bridge. In all the Cryptodira and the Trionychia these plates have been extirpated. If, then, we have not assigned too many pairs of ribs to the sternal region, there was originally involved in the preumbilical region the gastralia belonging to only two pairs of ribs, those of a pair of ribs for each pair of plastral elements.

It is possible that six sets of gastralia entered into the composition of the hypoplastra and xiphiplastra. However, we do not find, in Sphenodon or any other forms, that the pubic region is covered with gastralia. In Sphenodon there are three lumbar vertebræ, and some of the hindermost gastralia are much reduced in extent. If the plastron of most turtles extends beneath the pelvic region and even behind it, this is due doubtless to secondary modifications. The condition of the plastron of the Chelydridæ is probably more primitive. We must therefore believe that some of the hindermost gastralia become aborted. I am inclined to the opinion that we have at present in the hinder portion of the plastron elements representing only two pairs of ribs. If the hyoplastra and the mesoplastra each were developed from the gastralia belonging to a single pair of ribs, the same thing appears probable in the case of the hinder plastral elements. Otherwise we must assume that there has been coössification of originally distinct bones ; but the manner in which the mesoplastra have been thrust out of the plastron in most turtles indicates that here

[1] Boulenger. *Cat. of Chelonians*, p. 193, Fig. 47.
[2] *Op. cit.*, p. 199, Fig. 49.
[3] *Op. cit.*, p. 201, Fig. 51.

there is not much tendency toward coössification. This view is borne out by the suppression of the entoplastron in Dermochelys and the Cinosternidæ. For the same reason, and because the Ichthyosauria and the Plesiosauria seem to have possessed only one set of gastralia for each pair of ribs, I am inclined to believe that such was the condition in turtles. It appears that from the Stegocephali upward there has been a tendency toward a reduction in the number of sets of gastralia belonging to each body segment. If later on in the history of turtles certain plastral elements were excluded from the hinder portion of the plastron, as the mesoplastra have in most turtles been excluded, we have no record of the fact. If, then, our surmises are correct, the plastron of most of our turtles consists of the interclavicle, the clavicles, and elements derived from the gastralia corresponding to three pairs of ribs.

In turtles, it will be recalled, the plastral elements of the right and left sides are always distinct. In all for a varying period of life there is in the centre of the plastron a large fontanelle. In some, as Chelydra and the sea turtles, the fontanelle persists through life, or at least until a late period. We are safe in assuming that its existence is a primitive condition. On the other hand, in Sphenodon and in many of the extinct reptiles which possess gastralia, the median element is continuous across the mid-line of the abdomen. It seems therefore probable that the plastral bones of turtles, except clavicles and interclavicle, have been derived from the lateral elements of the primitive gastralia, while the median element has become aborted. I do not overlook the fact that in the crocodiles two distinct bones represent the median element found in the gastralia of Sphenodon. Even in the crocodiles, however, these bones are smaller than are those which lie farther from the mid-line.

U. S. NAT. MUSEUM,
October 10, 1898.

EDITORIALS.

The Editor-in-Chief. — We regret to announce that the present editor-in-chief finds it impossible to continue to devote to the *American Naturalist* the large amount of time that is required for its management, and that he feels compelled to relinquish his charge of the magazine with the issue of the current number.

We are very fortunate, however, in being able to find a successor who may be depended upon to do all that is possible to maintain the value of the *Naturalist* and make it interesting to its readers. One of our associate editors finds it necessary to withdraw on account of pressure of other work, but no further changes in the personnel are expected, and our aims and general policy will remain unchanged.

An Editor Found. — *Natural Science*, now in its thirteenth volume, has been most successful in filling a position in England similar to that which the *American Naturalist* has attempted to fill in this country. It was, in fact, the success of that review which inspired us with the hope that we might attain to a like high standard of excellence. It was with great regret, therefore, that we noted in the October number of *Natural Science* an announcement that the editor who has conducted the journal with so much ability is obliged to discontinue this work on account of increased responsibilities and lack of time. But what was still more to be regretted was that there appeared to be danger that the magazine might cease publication altogether for want of an editor.

We are very glad, indeed, to learn that this danger is now past, and that *Natural Science* will continue to appear as heretofore, arrangements having been made to transfer the journal to an editor who will conduct it on the present plan that has been found to be so satisfactory. We wish him great success.

Artificial Protoplasm. — During the past summer, Professor Alfonso L. Herrera, of the Museo Nacional, Mexico, very kindly sent us some "synthetic protoplasm" which he had prepared, as he says, from some of the substances which are to be found among the components of the myxomycete, *Fuligo septica, viz.*: pepsine, peptone, "fibrine acétique," oleic acid, soap, sugar, extract of bile, carbonates

of potassium, of calcium, and of ammonium, lactate of calcium, phosphates of calcium and of magnesium, sulphates of calcium and of iron, and chloride of sodium. When water and tartaric acid were added to this mixture, as directed, and the whole examined under the microscope, a very interesting and often complex series of currents were seen, both on the surface and within the mass. The currents would stream past one another in opposite directions, often reverse, and flow in new directions, and particles of the mingled substances in the soapy mass were often borne along in the current. This would continue from fifteen minutes to half an hour. But these movements were of the more fluid mixture of water and the soluble ingredients, and not of the substance of the mass. No protrusions of the nature of pseudopodia were seen, nor was there anything in the structure or activities of this substance that is truly characteristic of really living protoplasm. Professor Herrera states in his letter, however, that on one occasion when observing a drop of the "synthetic protoplasm" floating upon oil, he saw the production of a pseudopodium-like structure with a clear peripheral layer.

He also calls attention to the fact that oxygen is necessary for the vital processes, and suggests the interesting hypothesis that as the currents in the synthetic protoplasm are kept up by the liberation of carbon dioxide, the protoplasmic movements observed in animals and plants may be due to a similar process. This may be a suggestion in the right direction, but we think most naturalists will agree that this cannot go very far toward explaining the extremely complex activities of the living substance.

REVIEWS OF RECENT LITERATURE.

ANTHROPOLOGY.

Human Remains from Maya Territory.—A few broken calvaria, a few fragments of long bones, and a few sets of teeth are all the skeletal remains that we possess of the ancient inhabitants of the Maya territory. In the admirable report upon the ruins of Copan, by Maudsley, we read that "traces of bones were found," "a few small fragments of human bones were found," etc. The more recent explorations at the same ruin by the expeditions from the Peabody Museum have resulted in the discovery of "fragments" and "filed teeth." The few crania which, it might be inferred from the field notes, were well preserved and which are now in the Peabody Museum are in too fragmentary a condition to be available for study. In his account of the ruins of Xkichmook,[1] Mr. Edward Thompson describes the structure and architectural remains of an interesting group of ruins. We may readily believe that the "Palace," which he pictures in word, photograph, and plan, is "a most imposing structure," as its walls stand 64 feet high and are raised 80 feet above the surrounding level. Notwithstanding the probably dense population, as indicated by the extent of the ruins which formerly occupied the region, very few human remains were found. "Badly decayed human bones and teeth," "fragments of human bones much decayed," etc., is the record of the explorations among the burial chambers.

In a pleasantly written narrative[2] Mr. Gordon gives an account of the Honduras of to-day and of the vast quantities of potsherds and other artifacts that exist along the Uloa River. Whether or not they were manufactured by a race distinct from the Mayas, as suggested by Mr. Gordon and Professor Putnam in his editorial note, they indicate the presence of an extensive population in that valley in former times. However, the disappointing statement again appears, "The human remains . . . consist of crumbling fragments of bone . . .

[1] Thompson, Edward. Ruins of Xkichmook. Field Columbian Museum, *Anthropological Series*, vol. ii, No. 3.

[2] Gordon, George B. Researches in the Uloa Valley, Caverns of Copan, Honduras, *Memoirs of the Peabody Museum of American Archæology and Ethnology.* Cambridge, Mass. Vol. i (1898), Nos. 4 and 5.

too minute to supply any information respecting the form of the burials," or, what is much more important, the character of the skeletons themselves, from which the racial affinities of the people might perhaps be determined. Scarcely second in interest to the long-sought "Rosetta stone of the Mayas" would be a moderately large series of Maya skeletons in a fair state of preservation.

FRANK RUSSELL.

GENERAL BIOLOGY.

Variation in Seedlings. — Professor Herbert L. Jones [1] found in Cambridge, Mass., a sycamore maple, *Acer pseudoplanatus*, which produces seedlings showing a large number of abnormalities. The cotyledons show a tendency to be doubled, and all grades of doubling were found from a mere notch at the distal end of one cotyledon to four complete seed-leaves. Where one cotyledon is completely doubled, the plumule usually consists of a whorl of three leaves, but where there are four complete cotyledons there are never more than two leaves — a very curious correlation. R. P. B.

Chemical Analysis of the Plankton. — The chemical composition of the plankton of the Baltic Sea is discussed and compared with the analysis of certain agricultural products in a recent paper by Brandt.[2] The Copepoda, Peridinidæ, and diatoms are the predominant forms in the plankton of this body of water. Fifty cubic centimeters of plankton of mixed constitution weigh, when dried, from 1.08 to 1.74 grams; when diatoms predominate, the weight falls as low as .04 gram; and when Copepoda are abundant, it may rise as high as 2.1 grams. The results of the enumerations made of the organisms in the different catches subjected to analysis are utilized in the computation of their number in a gram of the dried plankton. It has thus been determined that it takes 675,000,000 diatoms (principally Chætoceros) or 42,000,000 to 65,000,000 Peridinidæ to weigh one gram; in the case of the marine Copepoda, from 300,000 to 500,000 are required; while the single analysis of a fresh-water plankton composed mainly of the larger individuals indicates that 50,000 to 124,000 are

[1] Jones, H. L. Unusual Forms of Maple Seedlings. Oberlin College, *Laboratory Bulletin* (1898), No. 9.

[2] Brandt, K. Beiträge zur Kenntniss der chemischen Zusammensetzung des Planktons. *Wissensch. Meeresuntersuchungen*, Neue Folge, Bd. iii (1898), Heft 2, pp. 45–90.

sufficient. It is further estimated that on the basis of total dry weight 1 copepod = 135 Peridinidæ = 1687 diatoms; when, however, only the ash-free matter is made the basis of comparison, 1 copepod = 127 Peridinidæ = 4407 diatoms. As the result of the analysis of 15 different catches, the chemical composition of the Copepoda, Peridinidæ, and of the diatoms was ascertained to be as follows, the amounts of the constituent substances being expressed in parts per hundred of the total dry weight.

	Albumen.	Chitin.	Fat.	Carbo-hydrates.	Ash.
Copepoda . . .	59.00	4.70	7.00	20.00	9.30
Peridinidæ . . .	13.00	—	1.40	80.60[1]	5.00
Diatoms[2] . . .	10.75	—	2.50	21.50	65.25[3]

The autumn and winter planktons of the Baltic are quite similar in their chemical composition, which is about midway between that of "rich pasturage" and green lupines, as shown in the following table.

Per Cent Dry Weight.	Albumen.	Fat.	Carbo-hydrates.	Ash.
Rich pasturage . . .	20.6	4.5	64.6	10.1
Autumn plankton . .	20.2–21.8	2.1–3.2	60.–68.9	8.5–15.7
Green lupines	20.6	2.6	72.	4.6

An October plankton, rich in Peridinidæ, principally Ceratium, differs materially from all land products used as fodder, in the small content of fat and the relatively large amount of carbohydrates (cellulose principally). Its nearest chemical counterparts among the products of the soil are to be found in rye straw and meadow hay.

Per Cent Dry Weight.	Albumen.	Fat.	N-Free Extract.	Cellulose.	Ash.
Rye straw . . .	3.5	1.5	38.8	51.3	4.7
Ceratium plankton	13.0	1.3	39.0	41.5	5.2
Meadow hay . .	13.6	3.2	48.2	26.8	8.2

[1] About 50 per cent of this is cellulose.
[2] Principally Chætoceros.
[3] About 50 per cent of this is SiO_2.

The spring plankton is characterized by the predominance of diatoms and a great increase in the amount of ash, which precludes any direct comparison with land plants. If, however, the comparison be based upon the ash-free substance of the diatoms, it is found that this differs from the richer food plants only in the greater proportion of fat, as the following table shows.

Per Cent Dry Weight.	Albumen.	Fat.	Carbo-hydrates.
Lupine — extra quality	29.3	2.8	67.8
Peas (kernels)	27.2	2.3	70.4
Diatoms	28.7	8.0	63.2

The summer plankton is predominantly animal, and thus presents a large amount of albumen, a fat-content at times low, at times abnormally high, and a relatively very small amount of carbohydrates. In these particulars its analysis resembles those of fish, mussels, and other marine animals.

C. A. K.

ZOOLOGY.

Morphology of Trematodes. — An interesting contribution to trematode morphology is contained in the recent paper by Pratt in the *Zoologische Jahrbücher*.[1] An investigation of *Apoblema appendiculatum* has brought to light a condition of the body covering which throws light upon the unsettled question concerning the nature of the outer layer of the body, or "cuticula," in trematodes and cestodes. Five principal views have been advanced concerning the nature of this layer. The older view of Schneider ('73) and Minot ('77) was that the layer is a basement membrane from which the overlying epithelium has been lost. Ziegler ('83) made the suggestion that the cuticula is to be regarded as an epithelium in which the nuclei, cell boundaries, etc., have become obliterated, a view which has attained considerable acceptance from the support given it in recent years by the writings of Braun and Monticelli. Brandes ('92) advanced the view that the layer arises as a secretion of the submuscular cells

[1] Pratt, H. S. A Contribution to the Life-History and Anatomy of the Appendiculate Distomes, *Zoologische Jahrbücher*, Abth. f. Anat., Bd. xi (1898).

which he considered to be glandular in function. Looss ('93) argued that the cuticular layer arises by the migration to the surface of the body of a material set free in the vacuolization of the parenchyma cells. These he believed to be derived from the layer of submuscular cells, which he compared to a Cambrian layer in plants. A ifth view was put forward by Blochmann ('96). According to his ingenious explanation, the outer body covering is a true cuticula secreted by a layer of epithelial cells which have elongated backward and come to lie beneath the layers of muscle fibres. They are more or less separated from one another and connected with the cuticula only by narrow processes extending between the muscle fibres and comparable with the ducts of gland cells.

Apoblema is an appendiculate trematode, and it is upon the cuticular layer covering the caudal appendix that the observations of special interest were made. In the earlier part of its life, passed within the body of a copepod, the caudal appendix is present only in the form of an invagination of the posterior end of the worm forming the caudal vesicle. Later, when the animal becomes free living, the caudal vesicle becomes everted to form the caudal appendix. After this has taken place there is no difference to be observed between the cuticular covering of the appendix and that of other parts of the body. It is a typical trematode cuticula destitute of spines and divisible into two layers, an outer and a deeper one, as shown by differences in reaction toward stains. Immediately beneath the cuticula are the usual layers of muscle fibres, circular and longitudinal, and the layer of submuscular cells. In the appendix, however, the latter layer is absent.

In the condition when the appendix is invaginated to form the caudal vesicle its cuticular layer is covered externally (toward the lumen of the vesicle) by a layer of columnar epithelial cells, over which is a delicate membrane — a true cuticula. In other words, in the caudal vesicle the layer which is later to become the cuticular covering of the appendix has precisely the relations of a basement membrane. About the time that the vesicle becomes evaginated to form the appendix, the layer of epithelial cells separates from the cuticular layer upon which it rests. Evidence for this, Pratt found in the presence of shriveled epithelium in the caudal vesicle nearly separated from the underlying cuticula.

This evidence from Apoblema furnishes strong support for the older theory that the body covering represents what was primarily a basement membrane. Pratt takes this view, but argues that the layer

has been modified and thickened by the addition to it of connective-tissue material from the deeper lying parenchyma. That the submuscular cells do not secrete this material is shown by the fact that the submuscular layer is absent from the caudal appendix of Apoblema, though the cuticular layer is as well developed there as over other parts of the body. It will be seen that the view which Pratt advocates is essentially the theory of Looss grafted upon the older view of Schneider and Minot. The evidence which he brings forward strongly antagonizes the views of Ziegler, Brandes, and Blochmann.

Pratt's account of the life-history of Apoblema differs from that given by previous investigators. He believes that the copepod is the primary host within which the young worm lives until it is nearly mature. It then escapes from the body of the copepod by forcing its way outward between two thoracic segments — a process which the author observed repeatedly. The young worm, while swimming about freely in the water, is probably swallowed by some fish, which thus becomes its final host.

W. S. NICKERSON.

Michigan Unionidæ.[1] — The distribution of the Unionidæ of Michigan has been worked out by Mr. Bryant Walker from a census which the Conchological Section of the Michigan Academy of Science has taken of all the known public and private collections within that state. Michigan possesses the richest unione fauna of all the territory tributary to the Great Lakes, and, as the state is wholly within the St. Lawrence basin, the problem is not complicated by the political boundaries of the investigation. Sixty-one species belonging to the genera Unio, Margaritina, and Anodonta are recognized. Of these only a small number have a general distribution; a few are peculiar to the northern part of the state; and several are confined to Lake Erie and the waters immediately tributary to it. On the other hand, a great majority of the total number (75 per cent of the species of Unio and Margaritina) are confined to the Grand-Saginaw valley and the region to the south of it. These forms are members of the fauna of the Mississippi basin, while those of the southeastern part of the state show decided affinities to the Ohian fauna. But two species peculiar to the fauna of the Atlantic region are found, and these have a general distribution throughout the state. Their westward migration could have taken place readily along existing waterways. On the other hand, the explanation of

[1] Walker, Bryant. *The Distribution of the Unionidæ in Michigan.* Detroit, 1898. Printed for the author. 20 pp., 3 pls.

the very large immigration of forms from the Mississippi and Ohio valleys is found by the author in the topographical changes incident to the glacial period. The formation of the Des Plaines and Maumee outlets to the lake region, as the ice-sheet receded, established the channels along which the Unionidæ of the Mississippi and the Ohio entered the Michigan area. The opening of the Grand-Saginaw valley as an outlet for the glacial lake Maumee into Lake Michigan, and the subsequent closing of the Maumee outlet, afforded the opportunity for the Unionidæ of the Mississippi to invade this region. It is a significant fact that the present range of the most of the invading species is still confined within the beach lines of the glacial lakes.

C. A. K.

The Plankton of Puget Sound.[1] — As the result of the examination of a vertical series of catches, taken at five levels in a depression in Puget Sound 112 fathoms in depth, the conclusion is reached that the surface strata present the greatest number of living individuals and furnish the most favorable, though irregular, conditions for their multiplication. The relative number of living and dead individuals changes in going from surface to bottom; for example, 82 per cent of Coscinodiscus in the surface water were alive, but only 29 per cent in the bottom water. A great accumulation of this genus in the deeper water is explained as the probable result of a previous, but no longer continuing, period of rapid growth in the surface water, followed by subsidence to the deeper strata. In the case of some diatoms the conditions of growth seem to be well fulfilled in the lower strata. Indeed, all the organisms of the plankton were found in a living condition throughout the 112 fathoms, excepting the Copepoda, which were not met with below 64 fathoms.

C. A. K.

Faune de France.[2] — This is the third volume issued of one of those convenient manuals of systematic biology so frequent in the Old World and so rare in the New. Would that we had something of the sort for other groups than vertebrates! The first volume of this *Fauna of France* dealt with the Coleoptera; the second embraced the rest of the Hexapoda. This volume contains the other Invertebrata, including the Thysanura, which were omitted from Vol. ii.

[1] Peck, J. I., and Harrington, N. R. Observations on the Plankton of Puget Sound, *Trans. N. Y. Acad. Sci.*, vol. xvi, pp. 378–387, Pls. XXXVII, XXXVIII.

[2] *Faune de France*, par A. Acloque, tome iii, 500 pp., 1664 figs., 18 mo. Paris, 1899. 10 frcs.

This work differs from the familiar *Leunis* in that it is a descriptive catalogue, incomplete in some of the smaller or more difficult forms, of all the animals within a certain geographical territory, with analytical keys of families, genera, and, in most cases, of species as well. The illustrations (process cuts), though small, are in most cases characteristic. While intended for France, American students will frequently find this volume of value because of the similarity of genera in many instances on the two continents and their seas. K.

Fishes New to New England. — In *Science*, No. 199, Mr. Hugh M. Smith gives notes on a number of fishes, mostly tropical in their general range, which have been taken in recent years at or near Woods Holl, Mass. The list includes the following species: *Germo alalunga*, the long-finned albacore; *Chætodon ocellatus*, the parche; *C. striatus*, the Portuguese butterfly; and a new species, *C. bricei; Neomenis aya*, the red snapper; *N. apodus*, the schoolmaster; *N. analis*, the mutton fish; *N. griseus*, the mangrove snapper; *N. jocu*, the dog snapper; *Canthidermis asperrimus*, a trigger fish; *Diodon hystrix*, porcupine fish; *Athlennes hians*, a marine gar; *Trachinotus goodei*, the black-finned pompano; two species of half-beaks, *Hemirhamphus braziliensis* and *Hyporhamphus roberte;* and a small file fish, *Alutera*, apparently new. There have now been reported from Woods Holl 222 species of fish — a larger number than from any other locality in the United States with the single exception of Key West.

Systematic Position of the Pycnogonids. — Ihle comes to the rather startling conclusions[1] that these forms must be regarded as tracheates which have lost their trachea and which are direct discordants of primitive myriapods. They have no near relationship with arachnids or crustaceans, and the few features in which they resemble these must be regarded as the results of convergence. They have so far departed from the myriapod stock that they must be regarded as a distinct class of tracheates.

Crustacea of the Northrop Collection.[2] — Dr. Rankin has published a list of the crustacea collected by Professor and Mrs. Northrop in the Bahamas during the year 1890. Most of the species are mentioned merely by name, with references to the original descriptions. Four new species and one new variety are

[1] *Biolog. Centralblatt*, Bd. xviii (1898), p. 603.

[2] Rankin, W. M. The Northrop Collection of Crustacea from the Bahamas, *Annals N. Y. Acad. Sci.*, vol. xi (1898), No. 12.

described and figured, *viz.: Stenopus scutellatus, Leander northropi, Alpheus hippothoë* de Man, var. *bahamensis, Alpheus nigro-spinatus,* and *Athanas ortmanni.* Descriptions are given also of *Uca leptodactyla* Guerin MS., *Stenopus hispidus* Latreille, and *S. semilævis* von Martens, and the two species of Stenopus are figured. The common Gonodactylus of the West Indies is mentioned under the name *G. œstedii* Hansen, although the difference between this form and *G. chiragra* Fabr. of the East Indies is very slight. R. P. B.

BOTANY.

A Monograph of the Genus Caulerpa.[1] — There is hardly any group of algæ so fascinating as the genus Caulerpa, though there is hardly any genus, certainly none among algæ of the same size, concerning which the known facts, except as to external form, are so few. A genus so distinctly marked that there is no question whatever as to its limits; containing from fifty to one hundred species, according as one takes the broader or the narrower idea of a species; the plants having a beauty, and at the same time a variety almost unrivaled, differentiated into a creeping stolon, sometimes several feet in length, roots going deep into the sand, and erect fronds, often very richly branched; and yet the whole plant consisting of a single cell. Abundant in all tropical and subtropical waters, an object of study by botanists for over fifty years, we are to-day absolutely ignorant of any form of reproduction other than by a portion of a frond breaking off and maintaining an independent existence and growth.

Not the least curious character of the Caulerpæ is the manner in which the erect fronds mimic the various higher plants. A list of the names of the twelve sections of the genus gives some idea of this; they are Vaucherioideæ, Charoidæ, Bryoideæ, Zosteroideæ, Phyllantoideæ, Filicoideæ, Hippuroideæ, Lycopodioideæ, Thuyoideæ, Araucarioideæ, Paspaloideæ, and Sedoideæ; and in the specific names this is carried still further, as in *C. taxifolia, C. selago, C. ericifolia, C. cactoides,* etc.

As usual in large genera, there is likely to be considerable difference of opinion as to the limits of species, especially when, as in this

[1] Monographie des Caulerpes, par Mme. A. Weber-Van Bosse. *Annales du Jardin Botanique de Buitenzorg,* tome XV, pp. 243–401, Pls. XX–XXIV.

case, very few of the species have been seen by their authors except as dried specimens; any one who has given any attention to the genus must recognize the difficulty of distinguishing many of the described species. With the intention of doing what was possible towards clearing up the subject, Mme. Weber-Van Bosse has made it a special study for several years, and the result is the paper just published in the *Annales du Jardin Botanique de Buitenzorg.*

Two long voyages to the tropics, specially for the observation of the living plants, and a careful study of the specimens in all the great herbaria of Europe, including authentic specimens of practically all described species, have placed the author in a position to carry out the work in a way heretofore impossible; and the paper which is the result of her studies leaves apparently little to be done in the way of classification and general arrangement of the genus. The grouping is practically the same as in Agardh's memoir of 1872; but the specific limits change considerably; varieties and forms in several cases representing what were before considered good species. Agardh's paper gave sixty-four species; De Toni's *Sylloge*, 1889, seventy-four, not including doubtful species; Mme. Weber describes five new species, but, including these, her list is only fifty-four. Any one who has struggled to distinguish the Florida and West Indian *C. juniperoides*, *C. cupressoides*, *C. ericifolia*, etc., not from a single specimen of each, but from a lot of some hundreds, will appreciate the justice of a classification which unites under *C. cupresoides* these and four more of the older species.

In the matter of nomenclature a number of changes have been made, usually to substitute an older specific name for the one commonly received; though in one or two cases, where this would result in the substitution of an obscure and also inappropriate name for a universally known and appropriate one, the change has not been made. The introductory chapter contains a full account of previous studies on the structure and growth of Caulerpa; the plates are excellent; the descriptions full; and the synonymy very complete, so much so that the absence of any index is a matter for regret.

As to the question of fructification, there are only a few tantalizing hints: in two instances, each in a different species, an arrangement of the protoplasm similar to that which precedes the formation of spores in certain genera of green algæ; the fact of the disappearance of certain species during certain months, and their regular reappearance; and one or two other indications pointing to the probability of growth from spores; these are all that we can learn. But the author

is planning another voyage to the Malay Archipelago for the express purpose of studying the question of fructification, and we may hope that it then will be settled.

A New Volume of De Toni's Sylloge. — The *Sylloge Algarum*,[1] by J. B. De Toni, begun in 1889, has now reached Vol. iv, of which the first section is just issued. This volume will contain the Florideæ, arranged on the Schmitz-Hauptfleisch system, as given in Engler and Prantl. A work like the *Sylloge*, giving a more or less complete diagnosis, in its appropriate systematic place, of every published species of alga, with references not only to the original publication but also to all the important works in which the species is mentioned, saves an immense amount of time otherwise needed in looking over the very scattered literature of the algæ. It should not be forgotten, however, that the *Sylloge* is not intended to be a critical revision, and any attempt to determine species of a large or difficult genus by it would give very uncertain results. In a work of this extent, so largely references, some omissions and errors are probably unavoidable, and it is hardly safe to copy any reference without verification; but perhaps this is the only safe rule, even with the most accurate works.

Studies on Phytoplankton. — The study of the plankton, the minute animal and vegetable life distributed through the sea, at all depths, has attracted much interest recently and seems likely to have important practical results. Recent publications, by Cleve[2] and others, indicate that the pelagic flora and fauna of each great region has a character of its own, and that by observing the changing character at any given locality it may be possible to ascertain from what oceanic region the currents are flowing at the time. At certain points on the coast of Sweden, for instance, the water at one time of the year shows the characteristics of the southern part of the German ocean; at another part of the year, the characters of the Arctic and North Atlantic. That a more thorough knowledge of the laws governing these changes may give some indication of the causes of the migrations of food fishes seems not improbable; the practical value of such knowledge would be very great.

[1] De Toni, J. B. *Sylloge Algarum hucusque cognitarum*, vol. iv, Florideæ, Sectio I, Familiæ I–IX. Patavii, 1897.

[2] Cleve, P. T. A Treatise on the Phytoplankton of the Atlantic and its Tributaries, and on the Periodical Changes of the Plankton of Skagerak. Upsala, 1897.

Cleve, P. T. Karaktäristik af Atlantiska Ocean vatten pa grund af dess mikroorganismer. Oefvers. K. Vetensk. Akad. Forhandl., Stockholm, 1897.

The Cryptogams of the River Elbe. — An interesting subject is treated by Dr. B. Schorler,[1] in his paper on the cryptogams of the river Elbe, and their effect on the impurities which the river receives from the city of Dresden. The subject is certainly not a threadbare one, and it is considered with German thoroughness; it seems probable that in many cases the relatively low algæ and the non-chlorophyllaceous Schizophytes may have a decided influence on the self-purifying of contaminated waters.

F. S. C.

Rockery and Aquarium Plants. — Attractively gotten-up handbooks for the amateur gardener, who wishes to diversify his collection, are Wocke's *Alpen-Pflanzen*[2] and Mönkemeyer's *Sumpf- und Wasserpflanzen.*[3] Both are pleasantly written and well illustrated. If a comparison were to be made between them, the first-named would be characterized as the better done.

T.

Nomenclature in Horticulture. — Prof. F. A. Waugh, in a little brochure recently issued,[4] calls attention to the need of general adoption of a consistent system of nomenclature for plants cultivated by the gardener and orchardist. His meaning is made clear by the citation in full of several examples of correct nomenclature and synonymic citation, taken from recent publications on fruits and garden vegetables.

T.

Botanical Notes. — "The Red Desert of Wyoming and its Forage Resources" is the title of a bulletin by Prof. Aven Nelson, recently published by the Division of Agrostology of the U. S. Department of Agriculture. The paper is illustrated by several reproductions of photographs showing the character of the desert growth, and by a number of figures of grasses and other plants.

Under the title "Studies in the Herbarium and the Field, No. 2," Miss Alice Eastwood, the active curator of the herbarium of the Cal-

[1] Schorler, A. Gutachten über die Vegetation der Elbe und ihre Bedeutung für die Selbstreinigung derselben. Dresden, 1897.

[2] Wocke, Erich. *Die Alpen-Pflanzen in der Garten-Kultur der Tiefländer.* Ein Leitfaden für Gärtner und Gartenfreunde. Berlin, Gustav Schmidt, 1898. 8vo, xii + 257 pp.

[3] Mönkemeyer, Wilh. *Die Sumpf- und Wasserpflanzen.* Ihre Beschreibung, Kultur und Verwendung. Berlin, Gustav Schmidt, 1897. 8vo, iv + 189 pp., ff. 126.

[4] Waugh, F. A. *Notes on Horticultural Nomenclature.* New York, American Gardening, 1898. 26 pp.

ifornia Academy of Sciences, publishes a series of articles on The plants of San Nicolas Island; New species of Cnicus from southern Colorado and Utah; The Colorado alpine species of Synthyris; The manzanitas of Mt. Tamalpais; Two species of Eriodictyon, heretofore included under *E. tomentosum;* and New species of Pacific Coast plants. Four excellent detail plates add to the value of the paper, which is brought out as No. 3 of the current botanical volume of the *Proceedings of the California Academy of Sciences.*

Mrs. Alice Carter Cooke, who, with her husband, has passed a considerable time in the Canary Islands, publishes popular articles on their flora in the *Bulletin of the Torrey Botanical Club* for July and the *Popular Science Monthly* for October. The last-mentioned article is attractively illustrated.

An address given by Professor Miall before the Royal Institution last February, on "A Yorkshire Moor," is published in *Nature*, Nos. 1503–4. It contains an ecological account of the principal moor-plants, and is illustrated by a number of habit and histological figures, which aid in rendering intelligible the modifications from normal structure by which these plants are adapted to their peculiar mode of life.

The genus Nigella is revised by Terracciano in a paper[1] reprinted from the *Bollettino del R. Orto Botanico di Palermo*, Vol. i, Nos. 3 and 4, and Vol. ii, No. 1.

An account of the Capparidaceous genus Boscia, to which is appended an analytical key to the species, based on leaf anatomy, is concluded in the *Bulletin de l'Herbier Boissier* of September 14. The paper is to be illustrated by fourteen plates, the publication of which, however, has been deferred until the next number of the *Bulletin.*

The extra-nuptial nectaries of Bombaceæ form the subject of an elaborate memoir by Dr. Achille Terracciano in the second fascicle of the current volume of *Contribuzioni alla biologia vegetale*, a publication of the Botanic Institute of Palermo. Several plates contain figures showing the distribution and structure of the organs.

Gillenia trifoliata, the Indian physic, is written of and figured in the *American Journal of Pharmacy* for October, in which is also contained the first of a series of tables for the qualitative examination of powdered vegetable drugs, by Henry Kraemer.

[1] Terracciano, Achille. *Revisione monografica delle specie del genere Nigella.* Palermo, 1897–8. 8vo, 62 pp.

Rosa stellata, a New Mexican relative of the Lower Californian *R. minutifolia*, which was described by Professor Wootton in the *Bulletin of the Torrey Botanical Club* of March last, is made the subject of a critical note by the eminent rhodologist Crépin, in the *Bulletin de l'Herbier Boissier* for September.

Rubber forms the subject of Pt. 8 of Vol. iii of the *Bulletin of Miscellaneous Information* of the Trinidad Botanic Gardens.

A paper by Blanc and Decrock, on the geographical distribution of the Primulaceæ, is brought to conclusion in the September number of the *Bulletin de l'Herbier Boissier*.

In Nos. 49–51 of *Die Gartenwelt*, Alwin Berger, curator of the acclimatization garden at La Mortola, on the Riviera, briefly describes the more common and attractive of the cultivated Agaves, illustrating his paper by half-tone reproductions of excellent photographs of a considerable number of species, which show these as they are grown in the open air at La Mortola.

The variability of the Norway spruce, *Picea excelsa*, is discussed at some length in a well-illustrated paper by C. Schröter, published in the August number of the *Vierteljahrsschrift der Naturforschenden Gesellschaft in Zürich*.

D. T. Johnson publishes a paper on the leaf and sporocarp of Pilularia in the *Botanical Gazette* for July, and a paper on the development of the leaf and sporocarp in *Marsilia quadrifolia*, in the *Annals of Botany* for June.

Laboratory Bulletin, No. 9, of Oberlin College, issued in June, is entirely devoted to botanical subjects: The effects of bloom on the transpiration of leaves, by Roberta Reynolds; A new species of Pyrenomycete parasitic on an alga; List of Ohio plants not recorded in the latest state catalogue; and Unusual forms of maple seedlings, — the last three by the late Professor Herbert L. Jones.

The *Proceedings of the Indiana Academy of Science* for 1897 contains the following botanical articles: Golden, Pure yeast in bread; Stone, The susceptibility of different starches to digestive ferments; Bryan, Evolution of free nitrogen in bacterial fermentations; Ferris, Microorganisms in flour; Bitting, The number of micro-organisms in air, water, and milk, as determined by their growth upon different media; Thomas, The effect of formalin on germinating seeds; Olive, A list of the Mycetozoa, collected near Crawfordsville; Snyder, The germ of pear blight; Arthur, Water power for botanical apparatus; Coul-

ter, Contributions to the flora of Indiana, No. 5, and Experiments in germination of composites; Cunningham, The Ericaceæ of Indiana, and Indiana's Gentianaceæ; Wright, Inarching of trees, and Notes on the cypress swamps of Knox County.

As President of the Michigan Academy of Science, Prof. V. M. Spalding delivered, some months since, an address on *A Natural History Survey of Michigan*, which has been issued in pamphlet form. His plea for the organization of such a survey is timely, and the results being reached in Wisconsin should make success reasonably certain if it were organized in the proper manner.

PETROGRAPHY AND MINERALOGY.

A New Edition of Dana's Mineralogy.[1] — The latest edition of Dana's *Text-Book of Mineralogy* is practically a new book. It is unquestionably the best text-book of modern mineralogy that has appeared. In its general make-up it resembles very closely the earlier editions of the book bearing the same title, but in its contents it varies widely from these. The entire book has been rewritten, and all of its parts have been brought quite up to date.

"In the chapter on crystallography, the different types of crystal forms are described under the now accepted thirty-two groups, classed according to their symmetry. The names given to these groups are based, so far as possible, upon the characteristic form of each, and are intended also to suggest the terms formerly applied in accordance with the principles of hemihedrism. The order adopted is that which alone seems suited to the demands of the elementary student, the special and mathematically simple groups of the isometric system being described first" (from author's preface). The discussion of crystallographic symmetry is remarkably simple. It should be clear to any student.

The section devoted to the explanation of the general principles of optics, and of the optical characters of minerals, is particularly welcome in an English text-book. All of the most important optical principles are expounded, the optical characteristics of the different crystal systems explained, and the methods used in determining their

[1] Dana, E. S. A Text-Book of Mineralogy, with an extended Treatise on Crystallography and Physical Mineralogy. New edition, entirely rewritten and enlarged. New York, John Wiley & Sons, 1898.

values are fully illustrated. This last-mentioned feature of the volume will be enthusiastically received by English-speaking teachers of mineralogy, since it embodies descriptions of methods heretofore available only in foreign text-books.

The descriptive part of the volume is essentially an abridgment of the sixth edition of Dana's *System of Mineralogy.*

Two excellent indices close the book. One is a general index, or index of topics, and the other an index to the mineral species discussed. The two occupy about twenty-two pages.

The volume constitutes an excellent introduction to modern mineralogy. It fills a want long felt by teachers who realize that the study of minerals is much more than a mere *description* of chemical compounds. This has long been understood on the continent of Europe, where the best mineralogical text-books have heretofore been published, and now, we are glad to say, it is being rapidly accepted as a truth in America; a fact due largely to the interest taken by American students in petrographical investigations. Professor Dana's text-book is the equal of any foreign text-book, either as a student's handbook of descriptive mineralogy or as an introduction to special works in petrography.

It is unnecessary to state that the treatment of all branches of the subject is accurate and as full as is desirable, since the author's name is a guarantee that the work is well done.

W. S. B.

Michigan Volcanics. — Clements[1] decribes a series of intrusive rocks from the Crystal Falls iron district in Michigan which he believes to be genetically connected. Embraced in the series are diorites, gabbros, norites, and peridotites. The diorites are intermediate in acidity. They vary in texture between granitic, ophitic, and micropegmatitic. Their plagioclase is andesine, but in addition to this feldspar they contain also considerable quantities of orthoclase. This mineral and quartz form the mesostasis. Brown and green hornblende are both present, the latter surrounding nuclei of the former. Both are regarded as primary. The mineralogical varieties of the rock recognized are: quartz-diorite, tonalite, quartz-mica-diorite, and mica-diorite. By the subordination of the plagioclase and an increase in the proportions of orthoclase and quartz present, the diorites pass into granites.

The gabbros and norites, like the diorites, contain more or less orthoclase and a large quantity of hornblende. This latter mineral

[1] *Journ. of Geol.*, vol. vi (1898), p. 372.

occurs in two varieties, a reddish brown and a dark green one, the latter only as zonal growths around the former. The hornblende-gabbros are occasionally porphyritic through the development in them of phenocrysts of brown hornblende. The peridotites include wehrlite, cortlandtite, and other types that grade into one another and into gabbro. In some of the peridotites the olivines are surrounded by rims of orthorhombic pyroxene, and these by rims of hornblende.

All these various rocks are regarded as belonging to one geological unit, the order of succession of its parts being gabbro, peridotite, and diorite, and, finally, possibly granite.

Analyses: Mica-diorite (I), hornblende-gabbros (II), bronzite-norite (III), and peridotite (IV).

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	K_2O	Na_2O	H_2O	P_2O_5	CO_2	Total
I.	58.51	.72	16.32	2.11	4.43	3.92	3.73	4.08	3.11	2.23	.30		= 99.46
II.	49.80	.79	19.96	6.32	.49	11.33	7.05	.61	2.22	1.84	.07	.15	= 100.63
III.	48.17	1.00	25.26	1.13	6.10	9.53	4.22	.73	1.34	2.19	.07	.43	= 100.17
IV.	44.99	.97	5.91	3.42	8.30	8.79	21.02	.74	.91	3.82	.05	tr.	= 99.17

The peridotite contains also .25 per cent Cr_2O_3.

California Rocks. — In an article discussing the geology of the coast ranges in California, Turner[1] gives some interesting information concerning the igneous and the metamorphic rocks of the district, and corrects some erroneous notions heretofore held concerning the latter. The metabasalts and diabases were thought by Whitney to be metamorphosed sandstones — a view also held by Becker concerning some of them. These are all igneous rocks of the usual character of altered basalts and diabases. The "fourchite" of Ransome from Angel Island is also a metabasalt (altered basalt). The serpentines, regarded by Whitney and by Becker as altered sandstones, are also shown by Turner to be altered igneous rocks in which olivine, or orthorhombic pyroxene, was an original constituent. The idea that the serpentine is a changed sandstone was due to the fact that some of the sandstones associated with it contain some igneous material, and that this has changed in part to serpentine.

The amphibole-schists and the blue amphibole-schists of the Golden Gate series were looked upon by Ransome and by Lawson as contact metamorphosed rocks. The author urges reasons for believing them to be regionally metamorphose volcanic masses.

Adirondack Gneisses. — Some interesting facts concerning the gneisses associated with the crystalline limestones in St. Lawrence

[1] *Journ. of Geol.*, vol. vi (1898), p. 483.

County, N. Y., are brought out by C. H. Smyth, Jr.,[1] in a recent paper. The term "gneiss" is made to cover all the gneissoid rocks of the district studied, whether they be acid or basic. All the gneisses are not of the same age; some are younger than the limestone with which they are associated. As to origin, it is definitely shown that a large portion of them are igneous. It is also inferred by the author that, "the gneisses constitute a complex series of rocks, differing somewhat in age, and largely, if not wholly, of igneous origin; parts of this series are clearly younger than the limestones, and while other parts may be older than the latter formation, there is nothing as yet to prove that this is the case. An exception to the latter statement is probably afforded by certain laminated gneisses of limited extent, which appear to underlie the limestone, perhaps marking the base of the series."

Notes. — Derby[2] has separated the constituents of the itacolumite of the Minas Geraes district, of Goyaz, and of Bahia, Brazil. The quartz grains show no evidence of clastic origin. The micaceous component is usually some form of muscovite, though occasionally it is some brittle mica. Magnetite, hematite, and pyrite are quite common. Rutile or anatase is frequently met with, and zircon is so abundant that it must be regarded as a concentration in a sediment. It moreover bears evidence of having been transported by water. A few of the specimens contain clastic grains of dark tourmaline that have been secondarily enlarged by the deposition of light-colored tourmaline around the dark nuclei. The result of the study leads the author to conclude that the itacolumite is a metamorphosed sandstone.

A list of dykes found by Cushing[3] in Clinton County, N. Y., is reported in a paper on the geology of Clinton County. The material of the dykes embraces diabase, olivine-diabase, bostonite, fourchite, camptonite, monchiquite, and fourchite.

[1] *Fifteenth Annual Report State Geologist.* Geol. Sur., State of N. Y., 1895, p. 481.

[2] *Amer. Journ. of Sci.*, vol. v (1898), p. 187.

[3] *Fifteenth Annual Report State Geologist.* Geol. Sur., State of N. Y., 1895, p. 503.

SCIENTIFIC NEWS.

THE *Report of the Essex Institute* for the past year is at hand. From it we learn that the society is likely to receive $10,000 by the will of the late George Plumer Smith, of Philadelphia, and an indefinite amount (we learn elsewhere estimated at $50,000) from the estate of the late George L. Ames, of Salem. The total number of additions to the library amount to 7123. The income for the year was $8040, the expenses $7970. The funds of the institute amount to over $100,000. The greatest present need is a stack for its library, which has increased far beyond its accommodations, so that many thousand volumes have had to be packed away.

The expedition recently sent out by Columbia University, with funds provided by Mr. Charles H. Senff, to obtain embryological material of the African mudfish, *Protopterus*, was not successful in its main object. It however brought back a quantity of the adult fish from the Nile and large collections of other material from the eastern Mediterranean and the Red Sea.

Those who have attentively examined the plates illustrating the papers turned out from the zoological laboratories of Harvard University will have noticed the peculiarity of the reference letters upon the figures. They are in all cases abbreviations of the Latin name of the structure and organ in question. At the recent Zoological Congress a committee was appointed consisting of Profs. F. E. Schulze, Paul Pelseneer, E. L. Mark, and Mr. A. H. Evans, who are to report upon the practicability of uniformity in abbreviations and other matters of terminology.

Mr. C. F. Baker, of the Alabama Experiment Station, goes, on Jan. 1, 1899, on a collecting trip to South America. He expects to be gone a year and a half.

John P. Marshall, professor of geology and mineralogy at Tufts College since its foundation, has resigned and has been appointed professor emeritus.

Dr. J. H. Gerould, assistant in zoology in Dartmouth College, will spend this year in Europe.

It has cost Columbia University nearly $7,000,000 to purchase land, erect its buildings, and to move to its new site.

The biological and geological departments of the Massachusetts Institute of Technology have moved into their new quarters in the Pierce Building recently erected. For years they have been in very cramped quarters.

In the *Journal of Applied Microscopy* America at last has a periodical devoted to microscopical technique, etc., worthy of the name. In this connection we notice, without regret, the decease of one of our alleged microscopical journals.

The French Association for the Advancement of Science has funds amounting to $220,000. Its income during the past year was over $20,000, and it granted more than $8000 at its meeting this year for scientific purposes.

As we are about to go to press the sad intelligence reaches us of the death of Dr. James I. Peck, assistant professor of biology in Williams College and assistant director of the Marine Biological Laboratory at Woods Holl.

Recent appointments: Prof. F. Blochmann, of Rostock, professor of zoology in the University of Tübingen. — Dr. L. Bordas, chief of zoological work in the faculty of sciences in Marseilles. — Antonio Borzi, professor of zoology and comparative anatomy in the University of Palermo, as successor to Kleinenberg. — Dr. T. D. A. Cockerell, professor of entomology in the New Mexico Agricultural College. — Dr. Rudolf Disselhorst, professor of animal physiology in the University of Halle. — Dr. A. Fleischmann, professor of zoology in the University of Erlangen. — Dr. C. Fritsch, director of the botanical collections of the University of Vienna. — M. Albert Gaillard, curator of the Lloyd herbarium at Angers, France. — Edwin S. Goodrich, demonstrator of anatomy in the University of Oxford. — Dr. D. Frazer Harris, lecturer in physiology in the University of St. Andrews. — Dr. Ernst Kalkowsky, director of the mineralogical, geological, and archæological collections in Dresden. — Dr. Keller, professor of zoology in the Polytechnicum at Zürich. — Dr. Kerschner, professor of histology in the University of Innsbruck. — Dr. Kolkwitz, privat docent in botany in the University of Berlin. — Alberto Löfgren, director of the botanical gardens at Sao Paulo, Brazil. — Charles P. Lounsbury, of Amherst, Mass., government entomologist at Cape Town, Africa. — Mr. J. H. McGregor, assistant in zoology in Columbian University. — Dr. M. von Minder, assistant in botany in the University of Giessen. — Dr. Mrensbier, professor extraordinarius of

comparative anatomy in the University of Moscow. — Mr. A. H. Phillips, assistant professor of mineralogy in Princeton University. — Dr. Fritz Römer, of Jena, assistant in the zoological museum in Berlin. — Dr. Fritz Schaudinn, privat docent for zoology in the University of Berlin. — Dr. Schröter, privat docent in botany in the University of Bonn. — Dr. O. Seeliger, of Berlin, professor of zoology in the University of Rostock. — Prof. C. H. Tyler Townsend, biogeographer and systematic entomologist to the New Mexico Agricultural Experiment Station. — Dr. Voges, director of the Bacteriological Institute at Buenos Ayres. — Prof. Georg Volkins, custodian of the botanical gardens in Berlin. — Dr. R. Wagner, of Munich, assistant in the Institute for Vegetable Physiology at Heidelberg. — E. O. Wooten, professor of botany in the New Mexico Agricultural College. Dr. Zograf, professor extraordinarius of zoology in the University of Moscow.

Recent deaths: Dr. Axel Blytt, professor of botany at Christiania, aged 54. — Dr. Sven Borgström, bryologist, at Stockholm, May 13, aged 72. — M. Joseph Charles Hippolyte Crosse, the well-known conchologist, at Vernon, France, August 7, aged 71. — Prof. John Comfort Fillmore, ethnologist, of Pomona College, California, August 14, at Taftville, Conn. — Camille Flagey, lichenologist, in Algiers, aged 62. — Prof. L. Glaser, entomologist, in Mannheim, Germany. — Dr. Arnold Graf, cytologist, of New York, in Boston, September 3, after a short illness. — Herbert L. Jones, professor of botany in Oberlin College, August 27, aged 32. — M. J. M. Moniez, naturalist, at Madeira, July 11. — M. Gabriel de Mortillet, the eminent anthropologist of France, aged 77. — Dr. August Pollmann, a prominent student of bees, at Bonn, May 16, aged 85.

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